(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 318 507 B1

(12) EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention of the grant of the patent:
10.10.2007 Bulletin 2007/41

(51) Int Cl.:
G11B 7/135 (2006.01) *G11B 7/09* (2006.01)
G11B 7/125 (2006.01)

(21) Application number: **02027289.4**

(22) Date of filing: **06.12.2002**

(54) **Optical information processing apparatus and method of processing optical information**

Optisches Informationsverarbeitungsgerät und Verfahren zur Verarbeitung optischer Information

Appareil de traitement d'information optique et méthode de traitement d'information optique

(84) Designated Contracting States:
DE FR GB

(30) Priority: **07.12.2001 JP 2001373682**

(43) Date of publication of application:
11.06.2003 Bulletin 2003/24

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(56) References cited:
EP-A- 1 130 581
WO-A-00/39792
US-A- 5 848 036
US-A1- 2001 021 146
US-A1- 2001 033 541
US-B1- 6 229 600

Printed by Jouve, 75001 PARIS (FR)

Description

[0001] The present invention relates to an optical information processing apparatus with an optical head for irradiating an optical information recording medium with light, converting the light reflected by the optical information recording medium into a head signal, and outputting the head signal. The present invention relates also to a method of processing optical information.

[0002] Optical discs called DVDs (Digital Versatile Disks) are commercially available as optical information recording media of high density and high capacity. Such optical discs have been used widely these days for recording media to record images, music, and computer data. Studies on optical discs for the next generation, i.e., optical discs having further improved recording density, have proceeded in many facilities. Such next-generation optical discs are expected as recording media for replacing videotapes used for the currently-dominating VTRs (Video Tape Recorders), and the development is pursued at a feverish pitch.

[0003] US patent document US-B1-5,848,036, which is used for the two-part form delimitation, discloses an optical disk drive equipped with means for performing optimization of a cut-off frequency of an equalizing filter, and a focus position, in order to minimize jitter.

[0004] Japanese laid-open patent application JP-A-10-106012 discloses a spherical aberration method comprising a drive for axially displacing a laser source.

[0005] Japanese laid-open patent application JP-A-2000-057616 discloses an optical pickup comprising convergence position adjustment means.

[0006] US patent document US-B1-6,229,600 discloses an optical player using a spherical aberration detection system operating separately from a focus error detection system.

[0007] An available technique for improving the recording density of an optical disc is to reduce the spot formed on a recording surface of an optical disc. Such a spot can be reduced by increasing the numerical aperture of light radiated from the optical head and decreasing the wavelength of the light.

[0008] However, a spherical aberration caused by an error in thickness of a protective layer formed on the optical disc will be increased rapidly when the numerical aperture of light radiated from the optical head is increased and the wavelength of the light is decreased. Therefore, a means for compensating the spherical aberration is required. The following description is about a conventional optical information processing apparatus having a means for compensating the spherical aberration.

[0009] FIG. 15 is a block diagram showing a configuration of a conventional optical information processing apparatus 90, and FIG. 16 is a block diagram for explaining a configuration of an optical head 5 provided in the conventional optical information processing apparatus 90. The optical head 5 in the optical information processing apparatus 90 has a semiconductor laser 123. A light beam 122 emitted from the semiconductor laser 123 passes through a prism 124, and it is collimated by a focusing lens 13 so as to be a substantially parallel light beam.

[0010] The light beam collimated by the focusing lens 13 passes through a concave lens and a convex lens provided in a spherical aberration compensator 7 and the light beam is reflected by a mirror 14. The light beam reflected by the mirror 14 is converged by an object lens 9 so as to form a spot on a recording surface formed on an optical disc 6, and reflected by the recording surface so as to form reflected light 33. The reflected light 33 passes again through the objective lens 9, and it is reflected by the mirror 14. Then, the light passes through the spherical aberration compensator 7, and it is focused by the focusing lens 13. After being focused by the focusing lens 13, the light 33 is reflected by a prism 124, and it passes through a hologram 115 provided for detecting a spherical aberration and also a cylindrical lens 116 provided for detecting a focal position so as to enter a photodetector 117.

[0011] The photodetector 117 generates a head signal on the basis of the reflected light 33 as incident light, and outputs the head signal into a preamp 18. The preamp 18 generates and outputs a focusing error signal FE according to astigmatism on the basis of the head signal outputted from the photodetector 117 provided in the optical head 5. Moreover, as disclosed in Tokuhyo-2001-507463 (published Japanese translation of PCT international publication for patent application), the preamp 18 detects separately a focusing error signal at the inner radius of the reflected light 33 and that of the rim of the reflected light 33, and generates a spherical aberration error signal SAE on the basis of the difference between the focusing error signals and outputs spherical aberration error signal SAE.

[0012] The focusing error signal FE outputted from the preamp 18 is inputted into a signal-amplitude instrument 20 via a switch 28. The signal-amplitude instrument 20 measures an amplitude of the focusing error signal FE and outputs the measurement result as a detection signal FE_{pp} into an amplitude-maximum probe 21. The amplitude-maximum probe 21 outputs a spherical aberration compensating signal ΔSAE into an adder 26 so that the detection signal FE_{pp} has a maximum amplitude.

[0013] The amplitude-maximum probe 21 searches for the spherical aberration, using the detection signal FE_{pp} as the evaluation value so as to obtain a maximum detection signal FE_{pp}. An example of the methods for searching for an optimum spherical aberration as described above includes varying the spherical aberration compensating signal ΔSAE slightly in order to slightly fluctuate the spherical aberration, checking a fluctuation of the amplitude of the detection signal FE_{pp} at that time, and varying the spherical aberration compensating signal ΔSAE for increasing the detection signal FE_{pp}.

[0014] Since a switch 27 is in an OFF-state, the adder

26 outputs the spherical aberration compensating signal ΔSAE from the amplitude-maximum probe 21 into a spherical aberration controller 12. The spherical aberration controller 12 outputs a control signal into a spherical aberration compensating actuator 8 provided in the spherical aberration compensator 7 of the optical head 5, on the basis of the spherical aberration compensating signal ΔSAE outputted from the adder 26, in order to vary a divergence of the light beam by varying spacing between two lenses provided in the spherical aberration compensator 7 and compensate the spherical aberration caused by an error in thickness of a protective layer formed on the optical disc 6.

[0015] The preamp 18 generates a reproduction signal RF by amplifying the head signal outputted from the optical head 5, and outputs the reproduction signal RF into a jitter detector 4. The jitter detector 4 measures jitter of the reproduction signal RF outputted from the preamp 18, and outputs the measurement result as a jitter detection signal JT into a minimum-jitter probe 91.

[0016] Here, the term 'jitter' denotes a physical quantity representing a time delay of an information transition for a reproduction signal. The jitter has a close relationship with an error rate representing the probability of error occurrence at the time of reading information from the optical disc. Therefore, the jitter is used as an evaluation value for controlling in the optical information processing apparatus.

[0017] The minimum-jitter probe 91 searches for a focal position having a minimum jitter value by using a technique similar to the above-described case where the amplitude-maximum probe 21 is used, and outputs a focal position compensating signal ΔFE into the adder 25. The switch 28 is turned to the adder 25, and the focusing error signal FE from the preamp 18 is outputted into the adder 25. The adder 25 performs addition of the focusing error signal FE outputted from the preamp 18 and the focal position compensating signal ΔFE outputted from the minimum-jitter probe 91, and outputs the result into the focusing controller 11. On the basis of the result of addition outputted from the adder 25, the focusing controller 11 outputs a control signal into a focusing actuator 10 provided in the optical head 5. On the basis of the control signal outputted from the focusing controller 11, the focusing actuator 10 drives the objective lens 9 along with a direction perpendicular to the optical disc 6 in order to control the focal position of the light beam converged on the optical disc 6. Accordingly, a focus control is performed.

[0018] Then, the switch 27 is turned from an OFF-state to an ON-state. Into the adder 26, the amplitude-maximum probe 21 outputs the spherical aberration compensating signal ΔSAE that maximizes the amplitude of the focusing error signal FE stored in advance of the performance of the focus control. The adder 26 performs addition of the spherical aberration SAE outputted from the preamp 18 and the spherical aberration compensating signal ΔSAE outputted from the amplitude-maximum probe 21 and outputs the result into the spherical aberration controller 12. On the basis of the addition result outputted from the adder 26, the spherical aberration controller 12 outputs the control signal into the spherical aberration compensating actuator 8 provided in the spherical aberration compensator 7 of the optical head 5. The spherical aberration compensating actuator 8, on the basis of the control signal outputted from the spherical aberration controller 12, varies spacing between two lenses provided in the spherical aberration compensator 7 and varies the divergence of the light beam in order to compensate the spherical aberration caused by an error in thickness of the protective layer formed on the optical disc 6.

[0019] In this manner, an optical disc apparatus according to the conventional technique compensates the spherical aberration first, and then searches for a focal position that minimizes the jitter value.

[0020] However, a recent study by the inventors clarified that the jitter may not be converged to its minimum value in the thus configured optical information processing apparatus.

[0021] FIGs. 17A-17C are graphs showing the relationship between a wave front aberration and a distance from a center of a light beam. The x-axis in each graph indicates a distance from a center of a light beam radiated from the optical head 5 onto the optical disc 6, and the y-axis indicates a wave front aberration. The wave front aberration is used for evaluating optical characteristics of the optical head since it has a close relationship with jitter.

[0022] FIG. 17A shows a relationship between a wave front aberration and a distance from a center of a light beam, where the light beam has a focal position at a location displaced by some degree from the recording surface formed on the optical disc along with a direction perpendicular to the surface of the optical disc. As shown in FIG. 17A, a curve indicating a relationship between the wave front aberration and a distance from a center of a light beam makes a quadratic curve in the case that the focal position of the light beam is displaced from the recording surface.

[0023] FIG. 17B shows a relationship between a wave front aberration and a distance from a center of a light beam when a spherical aberration is provided by 20 mλ using the spherical aberration compensator 7 for a case that the focal position is displaced as shown in FIG. 17A. As clearly indicated by the curve in FIG. 17B, the total wave front aberration is increased in a comparison with the total wave front aberration shown in FIG. 17A.

[0024] FIG. 17C shows a relationship between a wave front aberration and a distance from a center of a light beam when a spherical aberration is provided by -20 mλ using the spherical aberration compensator 7 in a case that the focal position is displaced as shown in FIG. 17A. As clearly indicated by the curve in FIG. 17C, the total wave front aberration is decreased in comparison with the total wave front aberration shown in FIG. 17A.

[0025] As described above, a total wave front aberration is increased for the case of FIG. 17B while it is decreased for the case of FIG. 17C even when providing spherical aberrations that are identical in the absolute value. This indicates that the focal position and the spherical aberration are influenced by each other, and that the focal position and the spherical aberration are under an influence of jitter.

[0026] In the above-described conventional optical information processing apparatus, the spherical aberration and the focal position are searched separately, for example, by searching for a spherical aberration that maximizes an amplitude of a focusing error signal and then searching for a focal position that minimizes a jitter value.

[0027] However, as described above, both the focal position and the spherical aberration influence jitter. Therefore, when the focal position and the spherical aberration are searched separately, a convergence result in the searches may vary depending on the initial focal position and the initial spherical aberration. This may result in failures in obtaining a result in a search to find a true minimum value of the jitter. When a searched jitter value is shifted from the true minimum value, reproduction signals will deteriorate. Moreover, either record information or address information recorded on the optical disc may not be read normally. Furthermore, information may not be recorded accurately since recording on the optical disc is carried out in a state that the spot of the light beam is spread.

[0028] The present invention aims to solve the above-described problems, and the object is to provide an optical information processing apparatus for obtaining a high quality signal reproduced from an optical disc, and a method of processing optical information.

[0029] For achieving the above-described objects, an optical information processing apparatus according to the present invention includes: an optical head for irradiating an optical information recording medium with light, converting the light into a head signal and outputting the head signal; a signal quality index detector for detecting a signal quality index representing quality of the head signal on the basis of the head signal outputted from the optical head; and a two-dimensional probe for varying the focal position and the spherical aberration of the radiated light so as to search for a focal position and a spherical aberration that optimize the signal quality index.

[0030] In the present specification, the term 'signal quality index' is an index representing the quality of a head signal converted using the optical head from light that is reflected by the optical information recording medium. The signal quality index includes, for example, jitter, an error rate, an amplitude of a reproduction signal, an amplitude of a tracking error signal, an amplitude of a focusing error signal, and an amplitude of a wobble signal.

[0031] A method of processing optical information according to the present invention includes: a step of irradiating an optical information recording medium with light, converting the light reflected by the optical information recording medium into a head signal, and outputting the head signal; a step of detecting a signal quality index representing the quality of the head signal on the basis of the head signal; and a step of varying the focal position and the spherical aberration of the radiated light so as to search for a focal position and a spherical aberration that optimize the signal quality index.

[0032] FIG. 1 is a block diagram showing a configuration of an optical information processing apparatus according to an embodiment of the present invention.

[0033] FIG. 2 is a block diagram for explaining the configuration of an optical head provided in an optical information processing apparatus according to an embodiment of the present invention.

[0034] FIG. 3 is a block diagram showing the configuration of a minimum-jitter probe provided in an optical information processing apparatus according to an embodiment of the present invention.

[0035] FIG. 4 is a graph showing a characteristic of jitter with respect to a focal position and a spherical aberration in an optical information processing apparatus according to an embodiment of the present invention.

[0036] FIG. 5 is a graph for explaining a two-dimensional search using an optical information processing apparatus according to an embodiment of the present invention.

[0037] FIG. 6 is a flow chart showing an operation for a two-dimensional search using an optical information processing apparatus according to an embodiment of the present invention.

[0038] FIG. 7 is a graph for explaining another two-dimensional search using an optical information processing apparatus according to an embodiment of the present invention.

[0039] FIG. 8 is a flow chart showing an operation for another two-dimensional search using an optical information processing apparatus according to an embodiment of the present invention.

[0040] FIG. 9 is a graph for explaining still another two-dimensional search using an optical information processing apparatus according to an embodiment of the present invention.

[0041] FIG. 10 is a flow chart showing an operation for still another two-dimensional search using an optical information processing apparatus according to an embodiment of the present invention.

[0042] FIG. 11 is a graph for explaining a still another two-dimensional search using an optical information processing apparatus according to an embodiment of the present invention.

[0043] FIG. 12 is a flow chart showing an operation for a still another two-dimensional search using an optical information processing apparatus according to an embodiment of the present invention.

[0044] FIG. 13 is a block diagram for explaining a configuration of another optical head provided in an optical

information processing apparatus according to an embodiment of the present invention.

[0045] FIG. 14 is a front view of a liquid crystal element provided in another optical head according to an embodiment of the present invention.

[0046] FIG. 15 is a block diagram showing a configuration of a conventional optical information processing apparatus.

[0047] FIG. 16 is a block diagram for explaining a configuration of an optical head provided in a conventional optical information processing apparatus.

[0048] FIGs. 17A-17C are graphs showing a relationship between a wave front aberration and a distance from a center of a light beam.

[0049] In an optical information processing apparatus according to an embodiment of the present invention, a focal position and a spherical aberration of light radiated onto an optical information recording medium are varied so that a two-dimensional probe searches for a focal position and a spherical aberration that optimize a signal quality index detected by a signal quality index detector. Accordingly, the value of the signal quality index can be optimized on the basis of the spherical aberration of the light radiated onto the optical information recording medium as well as on the basis of the focal position of the same light. As a result, the present invention provides an optical information processing apparatus that can optimize the quality of a head signal outputted from the optical head.

[0050] It is preferable that the two-dimensional probe includes a focal position probe for varying the focal position so as to search for a focal position that optimizes the value of the signal quality index and also a spherical aberration probe for varying the spherical aberration so as to search for a spherical aberration that optimizes the value of the signal quality index.

[0051] It is preferable that the two-dimensional probe searches for a focal position and a spherical aberration that optimize the value of the signal quality index by alternately repeating the search for the focal position by using the focal position probe and the search for the spherical aberration by using the spherical aberration probe.

[0052] It is preferable that the two-dimensional probe compares values of the signal quality indices at respective points (X_i, Y_j) so as to search for a point (X_a, Y_b) that optimizes the signal quality index, and repeats the search around the point (X_a, Y_b) while reducing a range ΔX and a range ΔY so as to obtain a focal position and a spherical aberration that optimize the signal quality index. The focal position is defined as a variable X and the spherical aberration is defined as a variable Y, a value of n ('n' is an integer bigger than 1) of the variable X within a range ΔX is denoted as X_i ('i' is 1 or an integer bigger than 1 and not bigger than n), and a value of m ('m' is an integer bigger than 1) of the variable Y within a range ΔY is denoted as Y_j ('j' is 1 or an integer bigger than 1 and not bigger than m).

[0053] It is preferable that, when the focal position is defined as a variable X and the spherical aberration is defined as a variable Y, the two-dimensional probe varies the focal position X at a predetermined spherical aberration Y1 so as to search for a focal position X1 that optimizes the signal quality index and varies the focal position X at a predetermined spherical aberration Y2 so as to search for a focal position X2 that optimizes the signal quality index, and the two-dimensional probe varies the focal position X and the spherical aberration Y on a straight line $Y = (Y2 - Y1)/(X2 - X1) \times (X - X1) + Y1$ that connects a point (X1, Y1) and a point (X2, Y2) so as to search for a focal position and a spherical aberration that optimize the signal quality index.

[0054] It is preferable that, when the focal position is defined as a variable X and the spherical aberration is defined as a variable Y, the two-dimensional probe varies the spherical aberration Y at a predetermined focal position X1 so as to search for a spherical aberration Y1 that optimizes the signal quality index and varies the spherical aberration Y at a predetermined focal position X2 so as to search for a spherical aberration Y2 that optimizes the signal quality index, and the two-dimensional probe varies the focal position X and the spherical aberration Y on a straight line $Y = (Y2 - Y1)/(X2 - X1) \times (X - X1) + Y1$ that connects a point (X1, Y1) and a point (X2, Y2) so as to search for a focal position and a spherical aberration that optimize the signal quality index.

[0055] It is preferable that, when the focal position is defined as a variable X and the spherical aberration is defined as a variable Y, the two-dimensional probe varies the focal position X and the spherical aberration Y on a straight line $Y = aX + Y0$ concerning a tilt a passing a predetermined spherical aberration Y0 so as to search for a focal position X1 and a spherical aberration Y1 that optimize the signal quality index value, and the two-dimensional probe varies the focal position X and the spherical aberration Y on a straight line $Y = -(X - X1)/a + Y1$ concerning a tilt $-1/a$ passing a point (X1, Y1) so as to search for a focal position and a spherical aberration that optimize the signal quality index value.

[0056] It is preferable that λ is 390 nm or more and 420 nm or less, NA is about 0.85, and the value of the tilt *a* is 0.1 /μm or more and 0.3 /μm or less, when λ denotes a wavelength of the light radiated onto the optical information recording medium and NA denotes a numerical aperture.

[0057] It is preferable that the signal quality index detected by the signal quality index detector is jitter and that the two-dimensional probe searches for a focal position and a spherical aberration that minimize the jitter.

[0058] It is preferable that the signal quality index detected by the signal quality index detector is an error rate and that the two-dimensional probe searches for a focal position and a spherical aberration that minimize the error rate.

[0059] It is preferable that the signal quality index detected by the signal quality index detector is an amplitude

of a reproduction signal and that the two-dimensional probe searches for a focal position and a spherical aberration that maximize the amplitude of the reproduction signal.

[0060] It is preferable that the signal quality index detected by the signal quality index detector is an amplitude of a tracking error signal and that the two-dimensional probe searches for a focal position and a spherical aberration that maximize the amplitude of the tracking error signal.

[0061] It is preferable that the signal quality index detected by the signal quality index detector is an amplitude of a wobble signal and that the two-dimensional probe searches for a focal position and a spherical aberration that maximize the amplitude of the wobble signal.

[0062] It is preferable that experimental information is recorded on the optical information recording medium and that the head signal converted from the light reflected by the optical information recording medium is obtained by reproducing the experimental information.

[0063] It is preferable that the signal quality index comprises a focusing error signal and a tracking error signal; the two-dimensional probe has a focal position probe for varying the focal position so as to search for a focal position that maximizes the amplitude of the tracking error signal, and a spherical aberration probe for varying the spherical aberration so as to search for a spherical aberration that maximizes the amplitude of the focusing error signal; and the optical head records the experimental information on the optical information recording medium at a spherical aberration that maximizes the amplitude of the focusing error signal and at a focal position that maximizes the amplitude of the tracking error signal.

[0064] A method of processing optical information according to an embodiment of the present invention includes a two-dimensional search step of varying a focal position and a spherical aberration of light radiated onto an optical information recording medium so as to search for a focal position and a spherical aberration that optimize a signal quality index detected in a step of detecting signal quality index. Thereby, the signal quality index can be optimized on the basis of a focal position of light radiated onto an optical information recording medium and also on the basis of a spherical aberration of the light radiated onto the optical information recording medium. As a result, the method according to the present invention can optimize the quality of a head signal output from an optical head.

[0065] It is preferable that the two-dimensional search comprises: a focal position search comprising varying the focal position so as to search for a focal position that optimizes the signal quality index, and a spherical aberration search comprising varying the spherical aberration so as to search for a spherical aberration that optimizes the signal quality index.

[0066] It is preferable that the two-dimensional search comprises alternate repetition of a search for the focal position by using the focal position probe and a search for the spherical aberration by using the spherical aberration probe so as to search for a focal position and a spherical aberration that optimize the signal quality index.

[0067] It is preferable in the two-dimensional search that the signal quality indices at the respective points (Xi, Yj) are compared so as to search for a point (Xa, Yb) that optimizes the signal quality index and the search around the point (Xa, Yb) is repeated while reducing a range ΔX and a range ΔY so as to obtain a focal position and a spherical aberration that optimize the signal quality index. The focal position is defined as a variable X and the spherical aberration is defined as a variable Y, a value of n ('n' is an integer bigger than 1) of the variable X within a range ΔX is denoted as Xi ('i' is 1 or an integer bigger than 1 and not bigger than n), and a value of m ('m' is an integer bigger than 1) of the variable Y within a range ΔY is denoted as Yj ('j' is 1 or an integer bigger than 1 and not bigger than m).

[0068] It is preferable in the two-dimensional search that, when the focal position is defined as a variable X and the spherical aberration is defined as a variable Y, the focal position X is varied at a predetermined spherical aberration Y1 so as to search for a focal position X1 that optimizes the signal quality index, and the focal position X is varied at a predetermined spherical aberration Y2 so as to search for a focal position X2 that optimizes the signal quality index, and the focal position X and the spherical aberration Y are varied on a straight line $Y = (Y2 - Y1)/(X2 - X1) \times (X - X1) + Y1$ that connects a point (X1, Y1) and a point (X2, Y2) so as to search for a focal position and a spherical aberration that optimize the signal quality index.

[0069] It is preferable in the two-dimensional search that, when the focal position is defined as a variable X and the spherical aberration is defined as a variable Y, the spherical aberration Y is varied at a predetermined focal position X1 so as to search for a spherical aberration Y1 that optimizes the signal quality index, and the spherical aberration Y is varied at a predetermined focal position X2 so as to search for a spherical aberration Y2 that optimizes the signal quality index, and the focal position X and the spherical aberration Y are varied on a straight line $Y = (Y2 - Y1)/(X2 - X1) \times (X - X1) + Y1$ that connects a point (X1, Y1) and a point (X2, Y2) so as to search for a focal position and a spherical aberration that optimize the signal quality index.

[0070] It is preferable in the two-dimensional search that, when the focal position is defined as a variable X and the spherical aberration is defined as a variable Y, the focal position X and the spherical aberration Y are varied on a straight line $Y = aX + Y0$ concerning a tilt a passing a predetermined spherical aberration Y0 so as to search for a focal position X1 and a spherical aberration Y1 that optimize the signal quality index, and that the focal position X and the spherical aberration Y are varied on a straight line $Y = -(X - X1)/a + Y1$ concerning a tilt $-1/a$ passing a point (X1, Y1) so as to search for a focal position and a spherical aberration that optimize

the signal quality index.

[0071] It is preferable that λ is 390 nm or more and 420 nm or less, NA is about 0.85, and the value of the tilt a is 0.1 λrms/μm or more and 0.3 λrms/μm or less, when λ denotes a wavelength of the light radiated onto the optical information recording medium and NA denotes a numerical aperture.

[0072] It is preferable in the two-dimensional search that the signal quality index detected by the signal quality index detector is jitter and that a focal position and a spherical aberration that minimize the jitter are searched for.

[0073] It is preferable in the two-dimensional search that the signal quality index detected by the signal quality index detector is an error rate and that a focal position and a spherical aberration that minimize the error rate are searched for.

[0074] It is preferable in the two-dimensional search that the signal quality index detected by the signal quality index detector is an amplitude of a reproduction signal and that a focal position and a spherical aberration that maximize the amplitude of the reproduction signal are searched for.

[0075] It is preferable in the two-dimensional search that the signal quality index detected by the signal quality index detector is an amplitude of a tracking error signal and that a focal position and a spherical aberration that maximize the amplitude of the tracking error signal are searched for.

[0076] It is preferable in the two-dimensional search that the signal quality index detected by the signal quality index detector is an amplitude of a wobble signal and that a focal position and a spherical aberration that maximize the value of amplitude of the wobble signal are searched for.

[0077] It is preferable that experimental information is recorded on the optical information recording medium and that the head signal converted from the light reflected by the optical information recording medium is obtained by reproducing the experimental information.

[0078] It is preferable that the signal quality index comprises a focusing error signal and a tracking error signal; the two-dimensional search includes varying the focal position so as to search for a focal position that maximizes the amplitude of the tracking error signal, and a spherical aberration detection includes varying the spherical aberration so as to search for a spherical aberration that maximizes the amplitude of the focusing error signal; and the optical head signal output includes recording of the experimental information on the optical information recording medium at a spherical aberration that maximizes the amplitude of the focusing error signal and at a focal position that maximizes the amplitude of the tracking error signal.

[0079] Embodiments of the present invention will be described below by referring to the attached drawings.

[0080] FIG. 1 is a block diagram showing a configuration of an optical information processing apparatus 100 according to an embodiment, and FIG. 2 is a block diagram for explaining a configuration of an optical head 5 provided in the optical information processing apparatus 100. FIG. 3 is a block diagram showing a configuration of a minimum-jitter probe 1 provided in the optical information processing apparatus 100.

[0081] The optical head 5 in the optical information processing apparatus 100 has a semiconductor laser 23. A light beam 22 emitted from the semiconductor laser 23 passes through a prism 24, and it is collimated by a focusing lens 13 so as to be a substantially parallel light beam.

[0082] The light beam collimated by the focusing lens 13 passes through a concave lens and a convex lens provided in a spherical aberration compensator 7, and it is reflected by a mirror 14. The light beam reflected by the mirror 14 is converged by an objective lens 9 so as to form a spot on a recording surface formed on an optical disc 6, and reflected by the recording surface. The light reflected by the recording surface, i.e., reflected light 33, passes through the objective lens 9 again. After being reflected by the mirror 14, the reflected light 33 passes through the spherical aberration compensator 7, and it is focused by the focusing lens 13. The reflected light 33 focused by the focusing lens 13 is reflected by the prism 24. Then, the reflected light 33 enters a photodetector 17, after passing through a hologram 15 provided for detecting a spherical aberration and a cylindrical lens 16 provided for detecting a focal position.

[0083] The photodetector 17 generates a head signal on the basis of the incident reflected light 33 and outputs the head signal into a preamp 18. The preamp 18 generates a focusing error signal FE according to astigmatism on the basis of a head signal outputted from the photodetector 17 provided in the optical head 5, and outputs the focusing error signal FE into an adder 25. The preamp 18 detects also the focusing error signals of the reflected light 33 at the inner radius and at the rim separately, generates a spherical aberration error signal SAE on the basis of a difference between the signals, and outputs the spherical aberration error signal SAE into an adder 26. Furthermore, the preamp 18 generates a reproduction signal RF by amplifying the head signal outputted from the optical head 5, and outputs the reproduction signal RF into a jitter detector 4. The jitter detector 4 measures jitter of the reproduction signal RF and outputs the result as a jitter detection signal JT into the minimum-jitter probe 1.

[0084] Here, the term 'jitter' denotes a physical quantity representing a time delay of an information transition for a reproduction signal. The jitter has a close relationship with an error rate representing the probability of error occurrence at the time of reading information from the optical disc. Therefore, jitter is used as an evaluation value for control in the optical information processing apparatus.

[0085] The minimum-jitter detector 1 has a focal position probe 2. The focal position probe 2 generates a focal

position compensating signal ΔFE and outputs it into the adder 25, so that the focal position probe 2 varies the focal position so as to search for a focal position that minimize the value of the jitter detection signal JT.

[0086] The minimum-jitter probe 1 has a spherical aberration probe 3. The spherical aberration probe 3 generates a spherical aberration compensating signal ΔSAE, so that it varies the spherical aberration so as to search for a spherical aberration that minimizes the value of the jitter detection signal JT.

[0087] The adder 25 performs an addition of the focusing error signal FE outputted from the preamp 18 and the focal position compensating signal ΔFE outputted from the focal position probe 2, and outputs the result into the focusing controller 11. The focusing controller 11 outputs a control signal into a focusing actuator 10 provided in the optical head 5, on the basis of the addition result outputted from the adder 25. The focusing actuator 10, on the basis of the control signal outputted from the focusing controller 11, drives the objective lens 9 along a direction perpendicular to the optical disc 6 so as to control the focal position of the light beam converged on the optical disc 6. Accordingly, focus control is carried out.

[0088] The adder 26 performs an addition of the spherical aberration error signal SAE outputted from the preamp 18 and the spherical aberration compensating signal ΔSAE outputted from the spherical aberration probe 3 and outputs the result into a spherical aberration controller 12. The spherical aberration controller 12, on the basis of the addition result outputted from the adder 26, outputs a control signal into a spherical aberration compensating actuator 8 provided in the spherical aberration compensator 7. The spherical aberration compensating actuator 8, on the basis of the control signal outputted from the spherical aberration controller 12, varies spacing between two lenses provided in the spherical aberration compensator 7 so that the divergence of the light beam is varied to compensate the spherical aberration occurring due to an error in thickness of a protective layer formed on the optical disc 6.

[0089] FIG. 4 is a graph showing a jitter characteristic with respect to the focal position and the spherical aberration in the optical information processing apparatus 100. The x-axis denotes a focal position of a light beam radiated from the optical head 5 onto the optical disc 6, and the y-axis denotes a spherical aberration of the light beam on a recording surface formed on the optical disc 6. The jitter values are indicated with a contour map composed of ellipses drawn concentrically. The jitter values on the rims of the respective ellipses are equal, and the value is decreased with approach to the centers of the respective ellipses. Therefore, the jitter values are minimized at the centers of the respective ellipses.

[0090] As shown in FIG. 4, the major axes and the minor axes of the respective ellipses have tilts with respect to the x-axis and the y-axis. This indicates that the focal position and the spherical aberration are influenced by each other regarding the jitter. Therefore, it is undesirable to adjust the focal position and the spherical aberration separately from each other from a viewpoint of minimizing the jitter, but the adjustment should be carried out while relating them. That is, a two-dimensional search is required considering both the focal position and the spherical aberration in order to minimize the jitter value.

[0091] The minimum-jitter probe 1 performs such a two-dimensional search, and it is composed of, e.g., a microprocessor in the optical information processing apparatus 100 according to the embodiment of the present invention. When the minimum-jitter probe 1 is composed of a microprocessor, a two-dimensional search can be carried out easily by programming even if the method of the two-dimensional search is complicated to some degree.

[0092] FIG. 5 is a graph for explaining a two-dimensional search using the optical information processing apparatus 100. Similar to the above-identified case concerning FIG. 4, the x-axis indicates a focal position and the y-axis indicates a spherical aberration. The jitter value is indicated with a contour map composed of ellipses drawn concentrically. Hereinafter, the focal point is indicated as X and the spherical aberration is indicated as Y for explanation.

[0093] First, the focal position probe 2 provided in the minimum-jitter probe 1 varies the focal position X on a straight line of a predetermined spherical aberration Y = Y1 so as to search for a focal position X1 that minimizes the jitter value. Then, the spherical aberration probe 3 varies the spherical aberration Y on a straight line of a predetermined focal position X = X1 so as to search for a spherical aberration Y2 that minimizes the jitter value. As a result of alternately repeated search for the focal position X by the focal position probe 2 and search for the spherical aberration Y by the spherical aberration probe 3, the jitter value is decreased as indicated by a zigzag line in FIG. 5. The repeated search is ended when the jitter value bottoms out and cannot be decreased by any of the search of the focal position X by using the focal position probe 2 or the search of spherical aberration Y by using the spherical aberration probe 3, thereby obtaining the focal position and the spherical aberration that minimize the jitter value.

[0094] FIG. 6 is a flow chart showing an operation for the two-dimensional search by using the optical information processing apparatus 100. First in step S1, initial values of a focal position X and a spherical aberration Y are set. The initial values have a small jitter that is previously set by experiments, simulations or the like to be decreased to a level enabling signal reproduction. In step S2, the focal position probe 2 varies the focal position X by a degree of ΔX. Later, the jitter detector 4 measures the jitter. Next in step S3, the focal position probe 2 decides whether the measured jitter value is minimized or not. The operation returns to step S2 so as to vary the focal position X by using the focal position probe 2 until the jitter value is minimized. When the jitter is minimized (YES in step S3), the operation goes to step S4.

[0095] In step S4, the spherical aberration probe 3 varies the spherical aberration Y by a degree of ΔY, and the jitter detector 4 measures the jitter. Later in step S5, the spherical aberration probe 3 decides whether the measured jitter value is minimized or not. The operation returns to step S4 so as to vary the spherical aberration Y by using the spherical aberration probe 3 until the jitter value is minimized. When the jitter is minimized (YES in step S5), the operation goes to step S6.

[0096] In step S6, the minimum-jitter probe 1 decides whether the jitter minimum value is converged or not, and steps S2-S5 are repeated until the value is converged. The condition for deciding whether the jitter minimum value is converged or not can be, for example, that a change in the jitter minimum value becomes a previously set value or lower than that. The two-dimensional search is ended when the jitter minimum value is converged (YES in step S6).

[0097] According to the above-described embodiment of the present invention, the focal position and the spherical aberration of a light beam radiated onto the optical disc 6 are varied so that the minimum-jitter probe 1 searches for a focal position and a spherical aberration that minimize the jitter value detected by the jitter detector 4. Accordingly, the jitter value can be optimized on the basis of the spherical aberration of the light beam radiated onto the optical disc 6 as well as the focal position of the light beam radiated onto the optical disc 6. Therefore, an optical information processing apparatus according to the present invention can optimize the quality of a reproduction signal reproduced on the basis of a head signal outputted from the optical head 5.

[0098] Though the signal quality index is jitter in a search for the focal position by using the focal position probe 2 and a search for the spherical aberration by using the spherical aberration probe 3 in this embodiment, the present invention is not limited to this example. The signal quality index can be an error rate, amplitude of a reproduction signal, amplitude of a tracking error signal, amplitude of a focusing error signal, amplitude of a wobble signal obtained by scanning a light spot on an information track wobbling due to a predetermined frequency. This can be applied to the following embodiments as well.

[0099] The jitter, the error rate and the reproduction signal can be obtained by using an optical head to reproduce a track on which disc information, address and data are recorded. For an unrecorded optical disc, experimental information generated by a recording signal generator 22 (FIG. 1) as a recording-signal generator is recorded on the optical disc 6, and the recorded experimental information is reproduced for obtaining the jitter, the error rate and the reproduction signal.

[0100] At this time, recording with a further focused spot can be obtained by recording the experimental information with a spherical aberration that maximizes the amplitude of the focusing error signal in the spherical aberration probe 3 and also at a focal position that maximizes the amplitude of the tracking errors signal in the focal position probe 2. The recorded experimental information can be erased after completing a search for a focal position and a spherical aberration that optimize the value of the signal quality index. Alternatively, an experiment track is provided on the optical disc 6 in order to record experimental information on the experiment track.

[0101] FIG. 7 is a graph for explaining another two-dimensional search by using the optical information processing apparatus 100. Similar to the above-described FIG. 5, the x-axis indicates a focal position and the y-axis indicates a spherical aberration. The jitter value is indicated with a contour map composed of ellipses drawn concentrically.

[0102] First, the minimum-jitter probe 1 searches for a point, among the five points of A_0, A_1, A_2, A_3 and A_4 in FIG. 7, which minimizes the jitter value. For each of the points A_1, A_2, A_3 and A_4, one side along the X-axis direction has a length of ΔX, and the points respectively form apices of a rectangle in which one side along the Y-axis has a length of ΔY. The point A_0 is located at the center of the rectangle composed of the points A_1, A_2, A_3 and A_4. In the contour map shown in FIG. 7, the point that minimizes the jitter value searched by the minimum-jitter probe 1 is the point A_0.

[0103] Next, the minimum-jitter probe 1 searches for a point, among the five points A_0, B_1, B_2, B_3 and B_4 in FIG. 7, that minimizes the jitter value. The points B_1, B_2, B_3 and B_4 form respectively apices of a rectangle centered on the point A_0. In the rectangle formed with the points B_1, B_2, B_3 and B_4, one side along with the X-axis direction is shorter than ΔX, and one side along with the Y-axis is shorter than ΔY. In the contour map shown in FIG. 7, the point that minimizes the jitter value searched by the minimum-jitter probe 1 is the point B_3.

[0104] Subsequently, the above-described search is repeated by centering the point B_3 that is obtained in this search as a point minimizing the jitter, and by decreasing further the ΔX and ΔY, thereby lowering the jitter value. The repeated search is ended when the jitter value bottoms out and cannot be decreased further. Thereby, a focal position and a spherical aberration that minimize the jitter value can be obtained. This method of search can decrease measurement points of jitter when compared to the method described referring to FIG. 5. Accordingly, the search can be carried out at a higher speed than the method concerning FIG. 5.

[0105] FIG. 8 is a flow chart showing operations for another two-dimensional search using the optical information processing apparatus 100. First in step S11, the minimum-jitter probe 1 sets initial values for the focal position X and the spherical aberration Y. The initial values have a small jitter that is set previously by experiments, simulations or the like to be decreased to a level enabling signal reproduction. In the following step S12, the minimum-jitter probe 1 sets five measurement points included in the ranges of ΔX and ΔY centering the initial value (X, Y). Next in step S13, the jitter detector 4 measures the

jitter values at the five measurement points, and the minimum-jitter probe 1 searches for a measurement point, among the five measurement points, which minimizes the jitter.

[0106] Later in step S14, the minimum-jitter probe 1 decides whether the jitter minimum value is converged or not. The conditions for decision of convergence can be, for example, that a change of the jitter minimum value becomes equal to or less than a previously-set value, or measurement values of jitter at the five measurement points are equalized.

[0107] In a case of a decision that the jitter minimum value is not converged (NO in step S14), steps S12 and S13 are repeated by further decreasing the values of ΔX and ΔY. In a case of a decision that the jitter minimum value is converged (YES in step S14), the two-dimensional search is ended. In this manner, a focus control and a spherical aberration control can be performed accurately by performing the two-dimensional search for obtaining a focal position and a spherical aberration that minimize the jitter.

[0108] Though the jitter measurement points included in the ranges of ΔX and ΔY are five in this embodiment, the present invention will not be limited thereto. The number of the jitter measurement points can be from 2 to 4, or it can be 6 or more.

[0109] As described above, according to the embodiment of the present invention, the minimum-jitter probe 1 searches for a point (Xa, Yb) that minimizes the jitter value by comparing the jitter values at respective points (Xi, Yj), and repeats the search around the point (Xa, Yb) by decreasing the ranges ΔX and ΔY. Here, the focal position is defined as a variable X and the spherical aberration is defined as a variable Y, a value of n ('n' is an integer bigger than 1) of the variable X within a range ΔX is denoted as Xi ('i' is 1 or an integer bigger than 1 and not bigger than n), and a value of m ('m' is an integer bigger than 1) of the variable Y within a range ΔY is denoted as Yj ('j' is 1 or an integer bigger than 1 and not bigger than m). Thereby, a focal position and a spherical aberration that minimize the jitter value can be obtained with accuracy.

[0110] FIG. 9 is a graph for explaining still another two-dimensional search by using the optical information processing apparatus 100. Similar to the above-identified case concerning FIG. 7, the x-axis indicates a focal position and the y-axis indicates a spherical aberration. The jitter value is indicated with a contour map composed of ellipses drawn concentrically.

[0111] First, the minimum-jitter probe 1 varies the focal position X on a straight line of a predetermined spherical aberration Y = Y1 so as to search for a focal position X1 that minimizes the jitter value. Next, the minimum-jitter probe 1 varies the focal position X on another straight line of a predetermined spherical aberration Y = Y2 so as to search for a focal position X2 that minimizes the jitter value.

[0112] Next, the minimum-jitter probe 1 varies the focal position X and the spherical aberration Y on a straight line $Y = (Y2 - Y2)/(X2 - X1) \times (X - X1) + Y1$ that connects the points (X1, Y1) and (X2, Y2) so as to search for a focal position and a spherical aberration that minimize the jitter value. This search method can further decrease the jitter measurement points than the method described referring to FIG. 7. Therefore, the search can be carried out at a still higher speed than the method concerning FIG. 7.

[0113] FIG. 10 is a flow chart indicating operations for still another two-dimensional search by the optical information processing apparatus 100. First in step S31, initial values regarding the focal position X and the spherical aberrations Y1 and Y2 are set. The initial values have a small jitter that is set previously by experiments, simulations or the like to be decreased to a level enabling signal reproduction. Next in step S32, the jitter is measured by varying the focal position X by a degree of ΔX on a straight line of the spherical aberration Y1. Next in step S33, it is decided whether the measured jitter value is minimum or not. When the measured jitter value is decided as not being minimum (NO in step S33), the operation returns to step S32 for varying the focal position X until the jitter value becomes minimum. When the measured jitter value is decided as minimum (YES in step S33), the operation goes to step S34.

[0114] In step S34, the focal position X is varied by a degree of ΔX on a straight line of the spherical aberration Y2 so as to measure the jitter. Next in step S35, the measured jitter value is decided whether it is the minimum or not. When the measured jitter value is decided as not being minimum (NO in the step S35), the operation returns to step S34 for varying the focal position X until the jitter value becomes minimum. When the measure jitter value is decided as minimum (YES in step S35), the operation goes to step S36.

[0115] Later in step S36, the focal position X is varied by a degree of ΔX, and the jitter is measured by using the spherical aberration Y as a value obtained by substituting X in a formula representing a straight line connecting a point (X1, Y1) and a point (X2, Y2), that is, $Y = (Y2 - Y2)/(X2 - X1) \times (X - X1) + Y1$. In step S37, it is decided whether the measured jitter value becomes minimum or not. When the measure jitter value is decided as not being minimum (NO in the step S37), the operation returns to step S36 for varying the focal position X and the spherical aberration Y until the jitter value becomes minimum. When the measured jitter value is decided as minimum (YES in step S37), the two-dimensional search is ended.

[0116] According to this embodiment of the present invention, when the focal position is defined as a variable X and the spherical aberration is defined as a variable Y, the minimum-jitter probe 1 varies the focal position X for a predetermined spherical aberration Y1 so as to search for a focal position X1 that minimizes the jitter value, and varies the focal position X for a predetermined spherical aberration Y2 so as to search for a focal position X2 that minimizes the jitter value, and thus it varies the

focal position X and the spherical aberration Y on a straight line $Y = (Y2 - Y1)/(X2 - X1) \times (X - X1) + Y1$ connecting a point (X1, Y1) and a point (X2, Y2) so as to search for a focal position and a spherical aberration that minimize the jitter value. Thereby, a focal position and a spherical aberration that minimize the jitter value can be obtained accurately at a high speed.

[0117] Here, the focal position X is searched under a condition of predetermined spherical aberrations Y = Y1 and Y = Y2. Needless to say, a similar search can be performed by searching for the spherical aberration Y under a condition of predetermined focal positions X = X1 and X = X2.

[0118] FIG. 11 is a graph for explaining still another two-dimensional search by using the optical information processing apparatus 100. First, the minimum-jitter probe 1 varies the focal position X and the spherical aberration Y on a straight line $Y = aX + Y0$ concerning a tilt a passing a predetermined spherical aberration Y0 so as to search for a focal position X1 and a spherical aberration Y1 that minimize the jitter value. Next, the minimum-jitter probe 1 varies the focal position X and the spherical aberration Y on a straight line $Y = -(X - X1)/a + Y1$ concerning a tilt $-1/a$ passing a point (X1, Y1) so as to search for a focal position and a spherical aberration that minimize the jitter value.

[0119] The tilt *a* is determined corresponding to the numerical aperture, the wavelength, and the recording method. When the tilt *a* is set as a value that is 0.1 λrms/μm or more and 0.3 λrms/μm or less (λ denotes a wavelength of light), it is effective for use in an optical head having a numerical number NA of 0.85 and used for irradiating an optical disc with light having a wavelength that is 390 nm or more and 420 nm or less.

[0120] The search method utilizes that the major axes and the minor axes composing the contour map representing a jitter characteristic have respectively certain tilts with respect to the x-axis and the y-axis. This can decrease further jitter measurement points in a comparison with the method described above referring to FIG. 9. Therefore, the search can be carried out at a higher speed than the method concerning FIG. 9.

[0121] FIG. 12 is a flow chart showing operations for a still another two-dimensional search by using the optical information processing apparatus 100. First in step S41, initial values for a tilt a and a spherical aberration Y0 are set. The initial values have a small jitter that is set previously by experiments, simulations or the like to be decreased to a level enabling signal reproduction. In step S42, the focal position X is varied by a degree of ΔX and the spherical aberration Y is determined as a value obtained by substituting X into a formula $Y = aX + Y0$, and thus the jitter is measured.

[0122] Next in step S43, it is decided whether the measured jitter value is minimum or not. When the measured jitter value is decided as not being minimum (NO in step S43), the operation returns to step S42 so as to vary the focal position X and the spherical aberration Y until the jitter value becomes minimum. When the measured jitter value is decided as minimum (YES in step S43), the operation goes to step S44.

[0123] In step S44, the focal position X is varied by a degree of ΔX and the spherical aberration Y is determined as a value obtained by substituting X into a formula $Y = -(X - X1)/a + Y1$ so as to measure the jitter. Next in step S45, the measured jitter value is evaluated as to whether it is the minimum or not. When the measured jitter value is decided as not being minimum (NO in the step S45), the operation returns to step S44 for varying the focal position X and the spherical aberration Y until the jitter value becomes minimum. When the measure jitter value is decided as minimum (YES in step S45), the two-dimensional search is ended.

[0124] According to this embodiment of the present invention, when the focal position is defined as a variable X and the spherical aberration is defined as a variable Y, the minimum-jitter probe 1 varies the focal position X and spherical aberration Y on a straight line $Y = aX + Y0$ concerning a tilt a passing a predetermined spherical aberration Y0 so as to search for a focal position X1 and a spherical aberration Y1 that optimize the jitter value, and varies the focal position X and a spherical aberration Y on a straight line $Y = -(X - X1)/a + Y1$ concerning a tilt $-1/a$ passing a point (X1, Y1) so as to search for a focal position and a spherical aberration that minimize the jitter value. Thereby, a focal position and a spherical aberration that minimize the jitter value can be obtained accurately at a high speed.

[0125] Though the spherical aberration is compensated by varying the spacing between two lenses provided in the spherical aberration compensator 7 of an optical head 5 in the above-described embodiment, the present invention is not limited thereto. Alternatively, the spherical aberration can be compensated by using a liquid crystal element.

[0126] FIG. 13 is a block diagram for explaining a configuration of another optical head 5A provided in the optical information processing apparatus 100 according to an embodiment of the present invention. FIG. 14 is a front view of a liquid crystal element 31 provided in the optical head 5A. Identical reference signs are used for components common to those of the optical head 5 described above by referring to FIG. 2. Therefore, detailed explanation will be omitted for these components. The optical head 5A is different from the above-described optical head 5 in that the spherical aberration compensator 7 is replaced by the liquid crystal element 31. As shown in FIG. 14, an electrode provided in the liquid crystal element 31 is divided into plural regions by concentric circles. The phase differences of light transmitted through the liquid crystal element 31 are controlled by adjusting voltages applied respectively to the electrodes provided in the respective regions, thereby compensating the spherical aberration.

[0127] Accordingly, the present invention can provide an optical information processing apparatus that im-

proves a signal reproduced from an optical disc, and the present invention can provide a method of processing optical information.

[0128] Summarized, an optical information processing method and apparatus is provided, including an optical head for irradiating an optical information recording medium with light, converting the light reflected by the optical information recording medium into a head signal and outputting the head signal; a signal quality index detector for detecting a signal quality index representing quality of the head signal on the basis of the head signal; and a two-dimensional probe for varying the focal position and the spherical aberration of the light radiated onto the optical information recording medium so as to search for a focal position and a spherical aberration that optimize the signal quality index detected by the signal quality index detector.

Claims

1. An optical information processing apparatus comprising:

    an optical head (5) for irradiating an optical information recording medium (6) with light, converting the light into a head signal after the light is reflected by the optical information recording medium (6), and outputting the head signal,
    a signal quality index detector (4) for detecting a signal quality index representing quality of the head signal on the basis of the head signal outputted from the optical head (5), and
    a two-dimensional probe (1, 2, 3) for varying a focal position (FE) and another parameter (SAE),

   characterized in that
   said other parameter is a spherical aberration (SAE) of the light radiated onto the optical information recording medium (6) so as for said two-dimensional probe (1, 2, 3) to search for a focal position (FE) and a spherical aberration (SAE) that optimize the signal quality index detected by the signal quality index detector (4), and **in that**
   a spherical aberration compensator (7) is provided, to which said two-dimensional probe (1, 2, 3) outputs a signal.

2. The optical information processing apparatus according to claim 1, wherein the two-dimensional probe comprises:

    a focal position probe (2) for varying the focal position so as to search for a focal position that optimizes the signal quality index, and
    a spherical aberration probe (3) for varying the spherical aberration so as to search for a spherical aberration that optimizes the signal quality index.

3. The optical information processing apparatus according to claim 2, wherein the two-dimensional probe repeats alternately the search for the focal position by using the focal position probe and the search for the spherical aberration by using the spherical aberration probe so as to search for a focal position and a spherical aberration that optimize the signal quality index.

4. The optical information processing apparatus according to one of claims 1 to 3, wherein
   when the focal position is defined as a variable X and the spherical aberration is defined as a variable Y, a value of n ('n' is an integer bigger than 1) of the variable X within a range ΔX is denoted as Xi ('i' is 1 or an integer bigger than 1 and not bigger than n), and a value of m ('m' is an integer bigger than 1) of the variable Y within a range ΔY is denoted as Yj ('j' is 1 or an integer bigger than 1 and not bigger than m), the two-dimensional probe compares values of the signal quality indices at the respective points (Xi, Yj) so as to search for a point (Xa, Yb) that optimizes the signal quality index, and repeats the search around the point (Xa, Yb) while reducing the range ΔX and the range ΔY so as to obtain a focal position and a spherical aberration that optimize the signal quality index.

5. The optical information processing apparatus according to one of claims 1 to 4, wherein when the focal position is defined as a variable X and the spherical aberration is defined as a variable Y,
   the two-dimensional probe varies the focal position X at a predetermined spherical aberration Y1 so as to search for a focal position X1 that optimizes the signal quality index and varies the focal position X at a predetermined spherical aberration Y2 so as to search for a focal position X2 that optimizes the signal quality index, and
   the two-dimensional probe varies the focal position X and the spherical aberration Y on a straight line Y = (Y2 - Y1)/(X2 - X1) x (X - X1) + Y1 that connects a point (X1, Y1) and a point (X2, Y2) so as to search for a focal position and a spherical aberration that optimize the signal quality index.

6. The optical information processing apparatus according to one of claims 1 to 5, wherein when the focal position is defined as a variable X and the spherical aberration is defined as a variable Y,
   the two-dimensional probe varies the spherical aberration Y at a predetermined focal position X1 so as to search for a spherical aberration Y1 that optimizes the signal quality index and varies the spherical aberration Y at a predetermined focal position

X2 so as to search for a spherical aberration Y2 that optimizes the signal quality index, and
the two-dimensional probe varies the focal position X and the spherical aberration Y on a straight line $Y = (Y2 - Y1)/(X2 - X1) \times (X - X1) + Y1$ that connects a point (X1, Y1) and a point (X2, Y2) so as to search for a focal position and a spherical aberration that optimize the signal quality index.

7. The optical information processing apparatus according to one of claims 1 to 6, wherein when the focal position is defined as a variable X and the spherical aberration is defined as a variable Y,
the two-dimensional probe varies the focal position X and the spherical aberration Y on a straight line $Y = aX + Y0$ concerning a tilt a passing a predetermined spherical aberration Y0 so as to search for a focal position X1 and a spherical aberration Y1 that optimize the signal quality index, and
the two-dimensional probe varies the focal position X and the spherical aberration Y on a straight line $Y = -(X - X1)/a + Y1$ concerning a tilt $-1/a$ passing a point (X1, Y1) so as to search for a focal position and a spherical aberration that optimize the signal quality index.

8. The optical information processing apparatus according to claim 7, wherein λ is 390 nm or more and 420 nm or less, NA is about 0.85, and the value of the tilt a is 0.1 λrms/μm or more and 0.3 λrms/μm or less, when λ denotes a wavelength of the light radiated onto the optical information recording medium and NA denotes a numerical aperture.

9. The optical information processing apparatus according to one of claims 1 to 8, wherein the signal quality index detected by the signal quality index detector is jitter, and the two-dimensional probe searches for a focal position and a spherical aberration that minimize the jitter.

10. The optical information processing apparatus according to one of claims 1 to 8, wherein the signal quality index detected by the signal quality index detector is an error rate, and the two-dimensional probe searches for a focal position and a spherical aberration that minimize the error rate.

11. The optical information processing apparatus according to one of claims 1 to 8, wherein the signal quality index detected by the signal quality index detector is an amplitude of a reproduction signal, and the two-dimensional probe searches for a focal position and a spherical aberration that maximize the amplitude of the reproduction signal.

12. The optical information processing apparatus according to one of claims 1 to 8, wherein the signal quality index detected by the signal quality index detector is an amplitude of a tracking error signal, and the two-dimensional probe searches for a focal position and a spherical aberration that maximize the amplitude of the tracking error signal.

13. The optical information processing apparatus according to one of claims 1 to 8, wherein the signal quality index detected by the signal quality index detector is an amplitude of a wobble signal, and the two-dimensional probe searches for a focal position and a spherical aberration that maximize the amplitude of the wobble signal.

14. The optical information processing apparatus according to one of claims 1 to 13, wherein the optical head irradiates the optical information recording medium with light so as to record experimental information, and the head signal converted from the light reflected by the optical information recording medium is obtained by reproducing the experimental information.

15. The optical information processing apparatus according to claim 14, wherein
the signal quality index comprises a focusing error signal and a tracking error signal;
the two-dimensional probe has a focal position probe for varying the focal position so as to search for a focal position that maximizes the amplitude of the tracking error signal, and a spherical aberration probe for varying the spherical aberration so as to search for a spherical aberration that maximizes the amplitude of the focusing error signal; and
the optical head records the experimental information on the optical information recording medium at a spherical aberration that maximizes the amplitude of the focusing error signal and at a focal position that maximizes the amplitude of the tracking error signal.

16. A method of processing optical information, comprising: an optical head signal output comprising irradiating an optical information recording medium with light, converting the light into a head signal after the light is reflected by the optical information recording medium, and outputting the head signal,
a signal quality index detection comprising detecting a signal quality index representing quality of the head signal on the basis of the head signal outputted from the optical head, and
a two-dimensional search comprising varying the focal position (S2) and another parameter (S4),
characterized in that
said other parameter is a spherical aberration of the light radiated onto the optical information recording medium so as to search for a focal position and a spherical aberration that optimize the signal quality

index detected by the signal quality index detector.

17. The method of processing optical information according to claim 16, wherein the two-dimensional search comprises:

a focal position search comprising varying the focal position so as to search for a focal position that optimizes the signal quality index, and
a spherical aberration search comprising varying the spherical aberration so as to search for a spherical aberration that optimizes the signal quality index.

18. The method of processing optical information according to claim 17, wherein the two-dimensional search comprises repeating alternately a search for the focal position by using the focal position probe and a search for the spherical aberration by using the spherical aberration probe so as to search for a focal position and a spherical aberration that optimize the signal quality index.

19. The method of processing optical information according to one of claims 16 to 18, wherein when the focal position is defined as a variable X and the spherical aberration is defined as a variable Y, a value of n ('n' is an integer bigger than 1) of the variable X within a range ΔX is denoted as Xi ('i' is 1 or an integer bigger than 1 and not bigger than n), and a value of m ('m' is an integer bigger than 1) of the variable Y within a range ΔY is denoted as Yj ('j' is 1 or an integer bigger than 1 and not bigger than m) in the two-dimensional search,
the signal quality indices at the respective points (Xi, Yj) are compared so as to search for a point (Xa, Yb) that optimizes the signal quality index and the search around the point (Xa, Yb) is repeated while reducing the range ΔX and the range ΔY so as to obtain a focal position and a spherical aberration that optimize the signal quality index.

20. The method of processing optical information according to one of claims 16 to 19, wherein when the focal position is defined as a variable X and the spherical aberration is defined as a variable Y in the two-dimensional search,
the focal position X is varied at a predetermined spherical aberration Y1 so as to search for a focal position X1 that optimizes the signal quality index, and the focal position X is varied at a predetermined spherical aberration Y2 so as to search for a focal position X2 that optimizes the signal quality index, and
the focal position X and the spherical aberration Y are varied on a straight line $Y = (Y2 - Y1)/(X2 - X1) \times (X - X1) + Y1$ that connects a point (X1, Y1) and a point (X2, Y2) so as to search for a focal position and a spherical aberration that optimize the signal quality index.

21. The method of processing optical information according to one of claims 16 to 20, wherein when the focal position is defined as a variable X and the spherical aberration is defined as a variable Y in the two-dimensional search,
the spherical aberration Y is varied at a predetermined focal position X1 so as to search for a spherical aberration Y1 that optimizes the signal quality index, and the spherical aberration Y is varied at a predetermined focal position X2 so as to search for a spherical aberration Y2 that optimizes the signal quality index, and
the focal position X and the spherical aberration Y are varied on a straight line $Y = (Y2 - Y1)/(X2 - X1) \times (X - X1) + Y1$ that connects a point (X1, Y1) and a point (X2, Y2) so as to search for a focal position and a spherical aberration that optimize the signal quality index.

22. The method of processing optical information according to one of claims 16 to 21, wherein when the focal position is defined as a variable X and the spherical aberration is defined as a variable Y in the two-dimensional search,
the focal position X and the spherical aberration Y are varied on a straight line $Y = aX + Y0$ concerning a tilt a passing a predetermined spherical aberration Y0 so as to search for a focal position X1 and a spherical aberration Y1 that optimize the signal quality index, and the focal position X and the spherical aberration Y are varied on a straight line $Y = -(X - X1)/a + Y1$ concerning a tilt $-1/a$ passing a point (X1, Y1) so as to search for a focal position and a spherical aberration that optimize the signal quality index.

23. The method of processing optical information according to claim 22, wherein λ is 390 nm or more and 420 nm or less, NA is about 0.85, and the value of the tilt a is 0.1 λrms/μm or more and 0.3 λrms/μm or less, when λ denotes a wavelength of the light radiated onto the optical information recording medium and NA denotes a numerical aperture.

24. The method of processing optical information according to one of claims 16 to 23, wherein the signal quality index detected by the signal quality index detector is jitter, and a focal position and a spherical aberration that minimize the jitter are searched for in the two-dimensional search.

25. The method of processing optical information according to one of claims 16 to 23, wherein the signal quality index detected by the signal quality index detector is an error rate, and a focal position and a spherical aberration that minimize the error rate are

searched for in the two-dimensional search.

26. The method of processing optical information according to one of claims 16 to 23, wherein the signal quality index detected by the signal quality index detector is an amplitude of a reproduction signal, and a focal position and a spherical aberration that maximize the amplitude of the reproduction signal are searched for in the two-dimensional search.

27. The method of processing optical information according to one of claims 16 to 23, wherein the signal quality index detected by the signal quality index detector is an amplitude of a tracking error signal, and a focal position and a spherical aberration that maximize the amplitude of the tracking error signal are searched for in the two-dimensional search.

28. The method of processing optical information according to one of claims 16 to 23, wherein the signal quality index detected by the signal quality index detector is an amplitude of a wobble signal, and a focal position and a spherical aberration that maximize the amplitude of the wobble signal are searched for in the two-dimensional search.

29. The method of processing optical information according to one of claims 16 to 28, wherein experimental information is recorded on the optical information recording medium, and the head signal converted from the light reflected by the optical information recording medium is obtained by reproducing the experimental information.

30. The method of processing optical information according to claim 29, wherein the signal quality index comprises a focusing error signal and a tracking error signal;
the two-dimensional search comprises a focal position search comprising varying the focal position so as to search for a focal position that maximizes the amplitude of the tracking error signal, and a spherical aberration search comprising varying the spherical aberration so as to search for a spherical aberration that maximizes the amplitude of the focusing error signal; and further comprises an optical head recording to record the experimental information on the optical information recording medium in advance of the optical head signal output, at a spherical aberration that maximizes the amplitude of the focusing error signal and at a focal position that maximizes the amplitude of the tracking error signal.

Patentansprüche

1. Optisches Informationsverarbeitungsgerät, umfassend:

einen optischen Kopf (5) zur Bestrahlung eines optischen Informationsaufzeichnungsmediums (6) mit Licht, zum Umwandeln des Lichts in ein Kopfsignal nach der Reflexion des Lichts durch das optische Informationsaufzeichnungsmedium (6), und zum Ausgeben des Kopfsignals,
einen Signalqualitätsindexdetektor (4) zum Erfassen eines die Qualität des Kopfsignals darstellenden Signalqualitätsindexes auf der Basis des von dem optischen Kopf (5) ausgegebenen Kopfsignals, und
eine zweidimensionale Sonde (1, 2, 3) zum Verändern einer Fokuslage (FE) und eines anderen Parameters (SAE),

dadurch gekennzeichnet, dass
dieser andere Parameter eine sphärische Aberration (SAE) des Lichts ist, das auf das optische Informationsaufzeichnungsmedium (6) gestrahlt wird, damit die zweidimensionale Sonde (1, 2, 3) nach einer Fokuslage (FE) und einer sphärischen Aberration (SAE) sucht, die den Signalqualitätsindex, der durch den Signalqualitätsindexdetektor (4) festgestellt wird, optimieren, und dass
ein Sphärische-Aberration-Kompensator (7) bereitgestellt ist, an den die zweidimensionale Sonde (1, 2, 3) ein Signal ausgibt.

2. Optisches Informationsverarbeitungsgerät gemäß Anspruch 1, wobei die zweidimensionale Sonde Folgendes umfasst:

eine Fokuslagen-Sonde (2) zum Verändern der Fokuslage, um nach einer Fokuslage zu suchen, die den Signalqualitätsindex optimiert, und
eine Sphärische-Aberration-Sonde (3) zum Verändern der sphärischen Aberration, um nach einer sphärischen Aberration zu suchen, die den Signalqualitätsindex optimiert.

3. Optisches Informationsverarbeitungsgerät gemäß Anspruch 2, wobei die zweidimensionale Sonde die Suche nach der Fokuslage durch Verwenden der Fokuslagen-Sonde und die Suche nach der sphärischen Aberration durch Verwenden der Sphärische-Aberration-Sonde abwechselnd wiederholt, um nach einer Fokuslage und einer sphärischen Aberration zu suchen, die den Signalqualitätsindex optimieren.

4. Optisches Informationsverarbeitungsgerät gemäß einem der Ansprüche 1 bis 3, wobei, wenn die Fokuslage als eine Variable X definiert ist und die sphärische Aberration als eine Variable Y definiert ist, ein Wert von n ('n' ist eine ganze Zahl größer als 1) der Variablen X innerhalb eines Bereichs ΔX als Xi ('i' ist 1 oder eine ganze Zahl größer als 1 und nicht

größer als n) bezeichnet ist, und ein Wert von m ('m' ist eine ganze Zahl größer als 1) der Variablen Y innerhalb eines Bereichs ΔY als Yj ('j' ist 1 oder eine ganze Zahl größer als 1 und nicht größer als m) bezeichnet ist,
die zweidimensionale Sonde Werte der Signalqualitätsindizes an den jeweiligen Punkten (Xi, Yj) vergleicht, um nach einem Punkt (Xa, Yb) zu suchen, der den Signalqualitätsindex optimiert, und die Suche um den Punkt (Xa, Yb) wiederholt; während der Bereich ΔX und der Bereich ΔY verringert wird, um eine Fokuslage und eine sphärische Aberration zu erhalten, die den Signalqualitätsindex optimieren.

5. Optisches Informationsverarbeitungsgerät gemäß einem der Ansprüche 1 bis 4, wobei, wenn die Fokuslage als eine Variable X definiert ist und die sphärische Aberration als eine Variable Y definiert ist,
die zweidimensionale Sonde die Fokuslage X bei einer vorbestimmten sphärischen Aberration Y1 verändert, um nach einer Fokuslage X1 zu suchen, die den Signalqualitätsindex optimiert, und die Fokuslage X bei einer vorbestimmten sphärischen Aberration Y2 verändert, um nach einer Fokuslage X2 zu suchen, die den Signalqualitätsindex optimiert, und die zweidimensionale Sonde die Fokuslage X und die sphärische Aberration Y auf einer geraden Linie $Y = (Y2 - Y1)/(X2 - X1) \times (X - X1) + Y1$, die einen Punkt (X1, Y1) und einen Punkt (X2, Y2) verbindet, verändert, um nach einer Fokuslage und einer sphärischen Aberration zu suchen, die den Signalqualitätsindex optimieren.

6. Optisches Informationsverarbeitungsgerät gemäß einem der Ansprüche 1 bis 5, wobei, wenn die Fokuslage als eine Variable X definiert ist und die sphärische Aberration als eine Variable Y definiert ist,
die zweidimensionale Sonde die sphärische Aberration Y bei einer vorbestimmten Fokuslage X1 verändert, um nach einer sphärischen Aberration Y1 zu suchen, die den Signalqualitätsindex optimiert, und die sphärische Aberration Y bei einer vorbestimmten Fokuslage X2 verändert, um nach einer sphärischen Aberration Y2 zu suchen, die den Signalqualitätsindex optimiert, und
die zweidimensionale Sonde die Fokuslage X und die sphärische Aberration Y auf einer geraden Linie $Y = (Y2 - Y1)/(X2 - X1) \times (X - X1) + Y1$, die einen Punkt (X1, Y1) und einen Punkt (X2, Y2) verbindet, verändert, um nach einer Fokuslage und einer sphärischen Aberration zu suchen, die den Signalqualitätsindex optimieren.

7. Optisches Informationsverarbeitungsgerät gemäß einem der Ansprüche 1 bis 6, wobei, wenn die Fokuslage als eine Variable X definiert ist und die sphärische Aberration als eine Variable Y definiert ist,
die zweidimensionale Sonde die Fokuslage X und die sphärische Aberration Y bezüglich einer Neigung *a*, die durch eine vorbestimmte sphärische Aberration Y0 verläuft, auf einer geraden Linie $Y = aX + Y0$ verändert, um nach einer Fokuslage X1 und einer sphärischen Aberration Y1 zu suchen, die den Signalqualitätsindex optimieren, und
die zweidimensionale Sonde die Fokuslage X und die sphärische Aberration Y bezüglich einer Neigung $-1/a$, die durch einen Punkt (X1, Y1) verläuft, auf einer geraden Linie $Y = -(X - X1)/a + Y1$ verändert, um nach einer Fokuslage und einer sphärischen Aberration zu suchen, die den Signalqualitätsindex optimieren.

8. Optisches Informationsverarbeitungsgerät gemäß Anspruch 7, wobei λ 390 nm oder mehr und 420 nm oder weniger beträgt, NA etwa 0,85 beträgt, und der Wert der Neigung *a* 0,1 λrms/μm oder mehr und 0,3 λrms/μm oder weniger beträgt, wenn λ eine Wellenlänge des Lichts ist, das auf das optische Informationsaufzeichnungsmedium gestrahlt wird, und NA eine numerische Apertur angibt.

9. Optisches Informationsverarbeitungsgerät gemäß einem der Ansprüche 1 bis 8, wobei der Signalqualitätsindex, der durch den Signalqualitätsindexdetektor festgestellt wird, Jitter ist, und die zweidimensionale Sonde nach einer Fokuslage und einer sphärischen Aberration sucht, die den Jitter minimieren.

10. Optisches Informationsverarbeitungsgerät gemäß einem der Ansprüche 1 bis 8, wobei der Signalqualitätsindex, der durch den Signalqualitätsindexdetektor festgestellt wird, eine Fehlerrate ist, und die zweidimensionale Sonde nach einer Fokuslage und einer sphärischen Aberration sucht, die die Fehlerrate minimieren.

11. Optisches Informationsverarbeitungsgerät gemäß einem der Ansprüche 1 bis 8, wobei der Signalqualitätsindex, der durch den Signalqualitätsindexdetektor festgestellt wird, eine Amplitude eines Wiedergabesignals ist, und die zweidimensionale Sonde nach einer Fokuslage und einer sphärischen Aberration sucht, die die Amplitude des Wiedergabesignals maximieren.

12. Optisches Informationsverarbeitungsgerät gemäß einem der Ansprüche 1 bis 8, wobei der Signalqualitätsindex, der durch den Signalqualitätsindexdetektor festgestellt wird, eine Amplitude eines Trackingfehlersignals ist, und die zweidimensionale Sonde nach einer Fokuslage und einer sphärischen Aberration sucht, die die Amplitude des Trackingfehlersignals maximieren.

13. Optisches Informationsverarbeitungsgerät gemäß einem der Ansprüche 1 bis 8, wobei der Signalqua-

litätsindex, der durch den Signalqualitätsindexdetektor festgestellt wird, eine Amplitude eines Wobbelsignals ist, und die zweidimensionale Sonde nach einer Fokuslage und einer sphärischen Aberration sucht, die die Amplitude des Wobbelsignals maximieren.

14. Optisches Informationsverarbeitungsgerät gemäß einem der Ansprüche 1 bis 13, wobei der optische Kopf das optische Informationsaufzeichnungsmedium mit Licht bestrahlt, um eine Versuchsinformation aufzuzeichnen, und das Kopfsignal, das aus dem durch das optische Aufzeichnungsmedium reflektierten Licht umgewandelt wird, durch Wiedergeben der Versuchsinformation erhalten wird.

15. Optisches Informationsverarbeitungsgerät gemäß Anspruch 14, wobei
der Signalqualitätsindex ein Fokussierungsfehlersignal und ein Trackingfehlersignal umfasst;
die zweidimensionale Sonde eine Fokuslagen-Sonde aufweist zum Verändern der Fokuslage, um nach einer Fokuslage zu suchen, die die Amplitude des Trackingfehlersignals maximiert, und eine Sphärische-Aberration-Sonde aufweist zum Verändern der sphärischen Aberration, um nach einer sphärischen Aberration zu suchen, die die Amplitude des Fokussierungsfehlersignals maximiert; und
der optische Kopf die Versuchsinformation bei einer sphärischen Aberration, die die Amplitude des Fokussierungsfehlersignals maximiert, und einer Fokuslage, die die Amplitude des Trackingfehlersignals maximiert, auf das optische Informationsaufzeichnungsmedium aufzeichnet.

16. Verfahren zur Verarbeitung optischer Information, umfassend:

Ausgeben eines Signals vom optischen Kopf, umfassend das Bestrahlen eines optischen Informationsaufzeichnungsmediums mit Licht, das Umwandeln des Lichts in ein Kopfsignal, nachdem das Licht durch das optische Informationsaufzeichnungsmedium reflektiert wurde, und das Ausgeben des Kopfsignals,
Feststellen eines Signalqualitätsindex, umfassend das Feststellen eines Signalqualitätsindex, der die Qualität des Kopfsignals darstellt, auf Basis des Kopfsignals, das vom optischen Kopf ausgegeben wird, und
Zweidimensionales Suchen, umfassend das Verändern der Fokuslage (S2) und eines anderen Parameters (S4),

dadurch gekennzeichnet, dass
der andere Parameter eine sphärische Aberration des Lichts ist, das auf das optische Informationsaufzeichnungsmedium gestrahlt wird, um nach einer Fokuslage und einer sphärischen Aberration zu suchen, die den Signalqualitätsindex, der durch den Signalqualitätsindexdetektor festgestellt wird, optimieren.

17. Verfahren zur Verarbeitung optischer Information gemäß Anspruch 16, wobei das zweidimensionale Suchen Folgendes umfasst:

eine Fokuslagensuche, umfassend das Verändern der Fokuslage, um nach einer Fokuslage zu suchen, die den Signalqualitätsindex optimiert, und
eine Sphärische-Aberrations-Suche, umfassend das Verändern der sphärischen Aberration, um nach einer sphärischen Aberration zu suchen, die den Signalqualitätsindex optimiert.

18. Verfahren zur Verarbeitung optischer Information gemäß Anspruch 17, wobei das zweidimensionale Suchen das abwechselnde Wiederholen eines Suchens nach der Fokuslage durch Verwenden der Fokuslagen-Sonde und eines Suchens nach der sphärischen Aberration durch Verwenden der Sphärische-Aberration-Sonde für die sphärische Aberration umfasst, um nach einer Fokuslage und einer sphärischen Aberration zu suchen, die den Signalqualitätsindex optimieren.

19. Verfahren zur Verarbeitung optischer Information gemäß einem der Ansprüche 16 bis 18, wobei, wenn beim zweidimensionalen Suchen die Fokuslage als eine Variable X definiert ist und die sphärische Aberration als eine Variable Y definiert ist, ein Wert von n ('n' ist eine ganze Zahl größer als 1) der Variablen X innerhalb eines Bereichs ΔX als Xi ('i' ist 1 oder eine ganze Zahl größer als 1 und nicht größer als n) bezeichnet ist, und ein Wert von m ('m' ist eine ganze Zahl größer als 1) der Variablen Y innerhalb eines Bereichs ΔY als Yj ('j' ist 1 oder eine ganze Zahl größer als 1 und nicht größer als m) bezeichnet ist, die Signalqualitätsindizes an den jeweiligen Punkten (Xi, Yj) verglichen werden, um nach einem Punkt (Xa, Yb) zu suchen, der den Signalqualitätsindex optimiert, und das Suchen um den Punkt (Xa, Yb) wiederholt wird, während der Bereich ΔX und der Bereich ΔY verringert wird, um eine Fokuslage und eine sphärische Aberration zu erhalten, die den Signalqualitätsindex optimieren.

20. Verfahren zur Verarbeitung optischer Information gemäß einem der Ansprüche 16 bis 19, wobei, wenn beim zweidimensionalen Suchen die Fokuslage als eine Variable X definiert ist und die sphärische Aberration als eine Variable Y definiert ist,
die Fokuslage X bei einer vorbestimmten sphärischen Aberration Y1 verändert wird, um nach einer Fokuslage X1 zu suchen, die den Signalqualitätsin-

dex optimiert, und die Fokuslage X bei einer vorbestimmten sphärischen Aberration Y2 verändert wird, um nach einer Fokuslage X2 zu suchen, die den Signalqualitätsindex optimiert, und die Fokuslage X und die sphärische Aberration Y auf einer geraden Linie $Y = (Y2 - Y1)/(X2 - X1) \times (X - X1) + Y1$, die einen Punkt (X1, Y1) und einen Punkt (X2, Y2) verbindet, verändert werden, um nach einer Fokuslage und einer sphärischen Aberration zu suchen, die den Signalqualitätsindex optimieren.

21. Verfahren zur Verarbeitung optischer Information gemäß einem der Ansprüche 16 bis 20, wobei, wenn beim zweidimensionalen Suchen die Fokuslage als eine Variable X definiert ist und die sphärische Aberration als eine Variable Y definiert ist, die sphärische Aberration Y bei einer vorbestimmten Fokuslage X1 verändert wird, um nach einer sphärischen Aberration Y1 zu suchen, die den Signalqualitätsindex optimiert, und die sphärische Aberration Y bei einer vorbestimmten Fokuslage X2 verändert wird, um nach einer sphärischen Aberration Y2 zu suchen, die den Signalqualitätsindex optimiert, und die Fokuslage X und die sphärische Aberration Y auf einer geraden Linie $Y = (Y2 - Y1)/(X2 - X1) \times (X - X1) + Y1$, die einen Punkt (X1, Y1) und einen Punkt (X2, Y2) verbindet, verändert werden, um nach einer Fokuslage und einer sphärischen Aberration zu suchen, die den Signalqualitätsindex optimieren.

22. Verfahren zur Verarbeitung optischer Information gemäß einem der Ansprüche 16 bis 21, wobei, wenn beim zweidimensionalen Suchen die Fokuslage als eine Variable X definiert ist und die sphärische Aberration als eine Variable Y definiert ist, die Fokuslage X und die sphärische Aberration Y bezüglich einer Neigung *a*, die durch eine vorbestimmte sphärische Aberration Y0 verläuft, auf einer geraden Linie $Y = aX + Y0$ verändert werden, um nach einer Fokuslage X1 und einer sphärischen Aberration Y1 zu suchen, die den Signalqualitätsindex optimieren, und die Fokuslage X und die sphärische Aberration Y bezüglich einer Neigung $-1/a$, die durch einen Punkt (X1, Y1) verläuft, auf einer geraden Linie $Y = -(X - X1)/a + Y1$ verändert werden, um nach einer Fokuslage und einer sphärischen Aberration zu suchen, die den Signalqualitätsindex optimieren.

23. Verfahren zur Verarbeitung optischer Information gemäß Anspruch 22, wobei λ 390 nm oder mehr und 420 nm oder weniger beträgt, NA etwa 0,85 beträgt, und der Wert der Neigung *a* 0,1 λrms/μm oder mehr und 0,3 λrms/μm oder weniger beträgt, wenn λ eine Wellenlänge des Lichts ist, das auf das optische Informationsaufzeichnungsmedium gestrahlt wird, und NA eine numerische Apertur angibt.

24. Verfahren zur Verarbeitung optischer Information gemäß einem der Ansprüche 16 bis 23, wobei der Signalqualitätsindex, der durch den Signalqualitätsindexdetektor festgestellt wird, Jitter ist, und beim zweidimensionalen Suchen nach einer Fokuslage und einer sphärischen Aberration gesucht wird, die den Jitter minimieren.

25. Verfahren zur Verarbeitung optischer Information gemäß einem der Ansprüche 16 bis 23, wobei der Signalqualitätsindex, der durch den Signalqualitätsindexdetektor festgestellt wird, eine Fehlerrate ist, und beim zweidimensionalen Suchen nach einer Fokuslage und einer sphärischen Aberration gesucht wird, die die Fehlerrate minimieren.

26. Verfahren zur Verarbeitung optischer Information gemäß einem der Ansprüche 16 bis 23, wobei der Signalqualitätsindex, der durch den Signalqualitätsindexdetektor festgestellt wird, eine Amplitude eines Wiedergabesignals ist, und beim zweidimensionalen Suchen nach einer Fokuslage und einer sphärischen Aberration gesucht wird, die die Amplitude des Wiedergabesignals maximieren.

27. Verfahren zur Verarbeitung optischer Information gemäß einem der Ansprüche 16 bis 23, wobei der Signalqualitätsindex, der durch den Signalqualitätsindexdetektor festgestellt wird, eine Amplitude eines Trackingfehlersignals ist, und beim zweidimensionalen Suchen nach einer Fokuslage und einer sphärischen Aberration gesucht wird, die die Amplitude des Trackingfehlersignals maximieren.

28. Verfahren zur Verarbeitung optischer Information gemäß einem der Ansprüche 16 bis 23, wobei der Signalqualitätsindex, der durch den Signalqualitätsindexdetektor festgestellt wird, eine Amplitude eines Wobbelsignals ist, und beim zweidimensionalen Suchen nach einer Fokuslage und einer sphärischen Aberration gesucht wird, die die Amplitude des Wobbelsignals maximieren.

29. Verfahren zur Verarbeitung optischer Information gemäß einem der Ansprüche 16 bis 28, wobei Versuchsinformation auf das optische Informationsaufzeichnungsmedium aufgezeichnet wird, und das Kopfsignal, das aus dem durch das optische Aufzeichnungsmedium reflektierten Licht umgewandelt wird, durch Wiedergeben der Versuchsinformation erhalten wird.

30. Verfahren zur Verarbeitung optischer Information gemäß Anspruch 29, wobei der Signalqualitätsindex ein Fokussierungsfehlersignal und ein Trackingfehlersignal umfasst;
das zweidimensionale Suchen ein Suchen nach einer Fokuslage, umfassend das Verändern der Fokuslage, um nach einer Fokuslage zu suchen, die

die Amplitude des Trackingfehlersignals maximiert, und ein Suchen nach einer sphärischen Aberration, umfassend das Verändern der sphärischen Aberration, um nach einer sphärischen Aberration zu suchen, die die Amplitude des Fokussierungsfehlersignals maximiert, umfasst; und ferner ein Aufzeichnen mit dem optischen Kopf umfasst, um die Versuchsinformation vor dem Ausgeben des Signals vom optischen Kopf bei einer sphärischen Aberration, die die Amplitude des Fokussierungsfehlersignals maximiert, und bei einer Fokuslage, die die Amplitude des Trackingfehlersignals maximiert, auf das optische Informationsaufzeichnungsmedium aufzuzeichnen.

Revendications

1. Appareil de traitement d'information optique comprenant :

    une tête optique (5) pour éclairer un support d'enregistrement d'information optique (6) avec une lumière, convertir la lumière en un signal de tête après que la lumière a été réfléchie par le support d'enregistrement d'information optique (6), et délivrer en sortie le signal de tête,
    un détecteur d'indice de qualité de signal (4) pour détecter un indice de qualité de signal représentant la qualité du signal de tête sur la base du signal de tête délivré en sortie de la tête optique (5), et
    une sonde bidimensionnelle (1, 2, 3) pour faire varier une position focale (FE) et un autre paramètre (SAE),
    caractérisé en ce que
    ledit autre paramètre est une aberration sphérique (SAE) de la lumière rayonnée sur le support d'enregistrement d'information optique (6) de manière à ce que la sonde bidimensionnelle (1, 2, 3) recherche une position focale (FE) et une aberration sphérique (SAE) qui optimisent l'indice de qualité de signal détecté par le détecteur d'indice de qualité de signal (4), et **en ce que** un compensateur d'aberration sphérique (7) est prévu, auquel ladite sonde bidimensionnelle (1, 2, 3) délivre en sortie un signal.

2. Appareil de traitement d'information optique selon la revendication 1, dans lequel la sonde bidimensionnelle comprend :

    une sonde de position focale (2) pour faire varier la position focale de manière à rechercher une position focale qui optimise l'indice de qualité de signal, et
    une sonde d'aberration sphérique (3) pour faire varier l'aberration sphérique de manière à rechercher une aberration sphérique qui optimise l'indice de qualité de signal.

3. Appareil de traitement d'information optique selon la revendication 2, dans lequel la sonde bidimensionnelle répète alternativement la recherche de la position focale en utilisant la sonde de position focale et la recherche de l'aberration sphérique en utilisant la sonde d'aberration sphérique de manière à rechercher une position focale et une aberration sphérique qui optimisent l'indice de qualité de signal.

4. Appareil de traitement d'information optique selon l'une des revendications 1 à 3, dans lequel

    lorsque la position focale est définie comme une variable X et l'aberration sphérique est définie comme une variable Y, une valeur de n (« n » est un entier supérieur à 1) de la variable X dans une plage ΔX est dénotée comme Xi (« i » est 1 ou un entier supérieur à 1 et non supérieur à n), et une valeur de m (« m » est un entier supérieur à 1) de la variable Y dans une plage ΔY est dénotée comme Yj (« j » est 1 ou un entier supérieur à 1 et non supérieur à m),
    la sonde bidimensionnelle compare les valeurs des indices de qualité de signal aux points respectifs (Xi, Yj) de manière à rechercher un point (Xa, Yb) qui optimise l'indice de qualité de signal, et répète la recherche autour du point (Xa, Yb) tout en réduisant la plage ΔX et la plage ΔY de manière à obtenir une position focale et une aberration sphérique qui optimisent l'indice de qualité de signal.

5. Appareil de traitement d'information optique selon l'une des revendications 1 à 4, dans lequel lorsque la position focale est définie comme une variable X et l'aberration sphérique est définie comme une variable Y,

    la sonde bidimensionnelle fait varier la position focale X à une aberration sphérique prédéterminée Y1 de manière à rechercher une position focale X1 qui optimise l'indice de qualité de signal et fait varier la position focale X à une aberration sphérique prédéterminée Y2 de manière à rechercher une position focale X2 qui optimise l'indice de qualité de signal, et
    la sonde bidimensionnelle fait varier la position focale X et l'aberration sphérique Y sur une ligne droite $Y = (Y2 - Y1)/(X2 - X1) \times (X - X1) + Y1$ qui relie un point (X1, Y1) et un point (X2, Y2) de manière à rechercher une position focale et une aberration sphérique qui optimisent l'indice de qualité de signal.

6. Appareil de traitement d'information optique selon

l'une des revendications 1 à 5, dans lequel lorsque la position focale est définie comme une variable X et l'aberration sphérique est définie comme une variable Y,

la sonde bidimensionnelle fait varier l'aberration sphérique Y à une position focale prédéterminée X1 de manière à rechercher une aberration sphérique Y1 qui optimise l'indice de qualité de signal et fait varier l'aberration sphérique Y à une position focale prédéterminée X2 de manière à rechercher une aberration sphérique Y2 qui optimise l'indice de qualité de signal, et
la sonde bidimensionnelle fait varier la position focale X et l'aberration sphérique Y sur une ligne droite $Y = (Y2 - Y1)/(X2 - X1) \times (X - X1) + Y1$ qui relie un point (X1, Y1) et un point (X2, Y2) de manière à rechercher une position focale et une aberration sphérique qui optimisent l'indice de qualité de signal.

7. Appareil de traitement d'information optique selon l'une des revendications 1 à 6, dans lequel lorsque la position focale est définie comme une variable X et l'aberration sphérique est définie comme une variable Y,

la sonde bidimensionnelle fait varier la position focale X et l'aberration sphérique Y sur une ligne droite $Y = aX + Y0$ concernant une inclinaison a passant une aberration sphérique prédéterminée Y0 de manière à rechercher une position focale X1 et une aberration sphérique Y1 qui optimisent l'indice de qualité de signal, et
la sonde bidimensionnelle fait varier la position focale X et l'aberration sphérique Y sur une ligne droite $Y = -(X - X1)/a + Y1$ concernant une inclinaison $-1/a$ passant un point (X1, Y1) de manière à rechercher une position focale et une aberration sphérique qui optimisent l'indice de qualité de signal.

8. Appareil de traitement d'information optique selon la revendication 7, dans lequel λ est 390 nm ou plus et 420 nm ou moins, NA est environ 0,85, et la valeur de l'inclinaison a est 0,1 λrms/μm ou plus et 0,3 λrms/μm ou moins, lorsque λ dénote une longueur d'onde de la lumière rayonnée sur le support d'enregistrement d'information optique et NA dénote une ouverture numérique.

9. Appareil de traitement d'information optique selon l'une des revendications 1 à 8, dans lequel l'indice de qualité de signal détecté par le détecteur d'indice de qualité de signal est une instabilité, et la sonde bidimensionnelle recherche une position focale et une aberration sphérique qui minimisent l'instabilité.

10. Appareil de traitement d'information optique selon l'une des revendications 1 à 8, dans lequel l'indice de qualité de signal détecté par le détecteur d'indice de qualité de signal est un taux d'erreurs, et la sonde bidimensionnelle recherche une position focale et une aberration sphérique qui minimisent le taux d'erreurs.

11. Appareil de traitement d'information optique selon l'une des revendications 1 à 8, dans lequel l'indice de qualité de signal détecté par le détecteur d'indice de qualité de signal est une amplitude d'un signal de reproduction, et la sonde bidimensionnelle recherche une position focale et une aberration sphérique qui maximisent l'amplitude du signal de reproduction.

12. Appareil de traitement d'information optique selon l'une des revendications 1 à 8, dans lequel l'indice de qualité de signal détecté par le détecteur d'indice de qualité de signal est une amplitude d'un signal d'erreur de poursuite, et la sonde bidimensionnelle recherche une position focale et une aberration sphérique qui maximisent l'amplitude du signal d'erreur de poursuite.

13. Appareil de traitement d'information optique selon l'une des revendications 1 à 8, dans lequel l'indice de qualité de signal détecté par le détecteur d'indice de qualité de signal est une amplitude d'un signal de vobulation, et la sonde bidimensionnelle recherche une position focale et une aberration sphérique qui maximisent l'amplitude du signal de vobulation.

14. Appareil de traitement d'information optique selon l'une des revendications 1 à 13, dans lequel la tête optique éclaire le support d'enregistrement d'information optique avec une lumière de manière à enregistrer une information expérimentale, et le signal de tête converti à partir de la lumière réfléchie par le support d'enregistrement d'information optique est obtenu en reproduisant l'information expérimentale.

15. Appareil de traitement d'information optique selon la revendication 14, dans lequel

l'indice de qualité de signal comprend un signal d'erreur de focalisation et un signal d'erreur de poursuite ;
la sonde bidimensionnelle a une sonde de position focale pour faire varier la position focale de manière à rechercher une position focale qui maximise l'amplitude du signal d'erreur de poursuite, et une sonde d'aberration sphérique pour faire varier l'aberration sphérique de manière à rechercher une aberration sphérique qui maximise l'amplitude du signal d'erreur de focalisation ; et

la tête optique enregistre l'information expérimentale sur le support d'enregistrement d'information optique à une aberration sphérique qui maximise l'amplitude du signal d'erreur de focalisation et à une position focale qui maximise l'amplitude du signal d'erreur de poursuite.

16. Procédé de traitement d'information optique comprenant :

une sortie de signal de tête optique comprenant l'éclairage d'un support d'enregistrement d'information optique avec une lumière, la conversion de la lumière en un signal de tête après que la lumière a été réfléchie par le support d'enregistrement d'information optique, et la délivrance en sortie du signal de tête,
une détection d'indice de qualité de signal comprenant la détection d'un indice de qualité de signal représentant la qualité du signal de tête sur la base du signal de tête délivré en sortie de la tête optique, et
une recherche bidimensionnelle comprenant de faire varier la position focale (S2) et un autre paramètre (S4),
caractérisé en ce que
ledit autre paramètre est une aberration sphérique de la lumière rayonnée sur le support d'enregistrement d'information optique de manière à rechercher une position focale et une aberration sphérique qui optimisent l'indice de qualité de signal détecté par le détecteur d'indice de qualité de signal.

17. Procédé de traitement d'information optique selon la revendication 16, dans lequel la recherche bidimensionnelle comprend :

une recherche de position focale comprenant de faire varier la position focale de manière à rechercher une position focale qui optimise l'indice de qualité de signal, et
une recherche d'aberration sphérique comprenant de faire varier l'aberration sphérique de manière à rechercher une aberration sphérique qui optimise l'indice de qualité de signal.

18. Procédé de traitement d'information optique selon la revendication 17, dans lequel la recherche bidimensionnelle comprend de répéter alternativement une recherche de la position focale en utilisant la sonde de position focale et une recherche de l'aberration sphérique en utilisant la sonde d'aberration sphérique de manière à rechercher une position focale et une aberration sphérique qui optimisent l'indice de qualité de signal.

19. Procédé de traitement d'information optique selon l'une des revendications 16 à 18, dans lequel lorsque la position focale est définie comme une variable X et l'aberration sphérique est définie comme une variable Y, une valeur de n (« n » est un entier supérieur à 1) de la variable X dans une plage ΔX est dénotée comme Xi (« i » est 1 ou un entier supérieur à 1 et non supérieur à n), et une valeur de m (« m » est un entier supérieur à 1) de la variable Y dans une plage ΔY est dénotée comme Yj (« j » est 1 ou un entier supérieur à 1 et non supérieur à m) dans la recherche bidimensionnelle,

les indices de qualité de signal aux points respectifs (Xi, Yj) sont comparés de manière à rechercher un point (Xa, Yb) qui optimise l'indice de qualité de signal, et la recherche autour du point (Xa, Yb) est répétée tout en réduisant la plage ΔX et la plage ΔY de manière à obtenir une position focale et une aberration sphérique qui optimisent l'indice de qualité de signal.

20. Procédé de traitement d'information optique selon l'une des revendications 16 à 19, dans lequel lorsque la position focale est définie comme une variable X et l'aberration sphérique est définie comme une variable Y dans la recherche bidimensionnelle,

la position focale X est fait varier à une aberration sphérique prédéterminée Y1 de manière à rechercher une position focale X1 qui optimise l'indice de qualité de signal et la position focale X est fait varier à une aberration sphérique prédéterminée Y2 de manière à rechercher une position focale X2 qui optimise l'indice de qualité de signal, et
la position focale X et l'aberration sphérique Y sont fait varier sur une ligne droite Y = (Y2 - Y1) / (X2 - X1) x (X - X1) + Y1 qui relie un point (X1, Y1) et un point (X2, Y2) de manière à rechercher une position focale et une aberration sphérique qui optimisent l'indice de qualité de signal.

21. Procédé de traitement d'information optique selon l'une des revendications 16 à 20, dans lequel lorsque la position focale est définie comme une variable X et l'aberration sphérique est définie comme une variable Y dans la recherche bidimensionnelle,

l'aberration sphérique Y est fait varier à une position focale prédéterminée X1 de manière à rechercher une aberration sphérique Y1 qui optimise l'indice de qualité de signal et l'aberration sphérique Y est fait varier à une position focale prédéterminée X2 de manière à rechercher une aberration sphérique Y2 qui optimise l'indice de qualité de signal, et
la position focale X et l'aberration sphérique Y sont fait varier sur une ligne droite Y = (Y2 - Y1)

/(X2 - X1) x (X - X1) + Y1 qui relie un point (X1, Y1) et un point (X2, Y2) de manière à rechercher une position focale et une aberration sphérique qui optimisent l'indice de qualité de signal.

22. Procédé de traitement d'information optique selon l'une des revendications 16 à 21, dans lequel lorsque la position focale est définie comme une variable X et l'aberration sphérique est définie comme une variable Y dans la recherche bidimensionnelle,

la position focale X et l'aberration sphérique Y sont fait varier sur une ligne droite Y = aX + Y0 concernant une inclinaison a passant une aberration sphérique prédéterminée Y0 de manière à rechercher une position focale X1 et une aberration sphérique Y1 qui optimisent l'indice de qualité de signal, et
la position focale X et l'aberration sphérique Y sont fait varier sur une ligne droite Y = -(X - X1) /a + Y1 concernant une inclinaison -1/a passant un point (X1, Y1) de manière à rechercher une position focale et une aberration sphérique qui optimisent l'indice de qualité de signal.

23. Procédé de traitement d'information optique selon la revendication 22, dans lequel λ est 390 nm ou plus et 420 nm ou moins, NA est environ 0,85, et la valeur de l'inclinaison a est 0,1 λrms/μm ou plus et 0,3 λrms/μm ou moins, lorsque λ dénote une longueur d'onde de la lumière rayonnée sur le support d'enregistrement d'information optique et NA dénote une ouverture numérique.

24. Procédé de traitement d'information optique selon l'une des revendications 16 à 23, dans lequel l'indice de qualité de signal détecté par le détecteur d'indice de qualité de signal est une instabilité, et une position focale et une aberration sphérique qui minimisent l'instabilité sont recherchées dans la recherche bidimensionnelle.

25. Procédé de traitement d'information optique selon l'une des revendications 16 à 23, dans lequel l'indice de qualité de signal détecté par le détecteur d'indice de qualité de signal est un taux d'erreurs, et une position focale et une aberration sphérique qui minimisent le taux d'erreurs sont recherchées dans la recherche bidimensionnelle.

26. Procédé de traitement d'information optique selon l'une des revendications 16 à 23, dans lequel l'indice de qualité de signal détecté par le détecteur d'indice de qualité de signal est une amplitude d'un signal de reproduction, et une position focale et une aberration sphérique qui maximisent l'amplitude du signal de reproduction sont recherchées dans la recherche bidimensionnelle.

27. Procédé de traitement d'information optique selon l'une des revendications 16 à 23, dans lequel l'indice de qualité de signal détecté par le détecteur d'indice de qualité de signal est une amplitude d'un signal d'erreur de poursuite, et une position focale et une aberration sphérique qui maximisent l'amplitude du signal d'erreur de poursuite sont recherchées dans la recherche bidimensionnelle.

28. Procédé de traitement d'information optique selon l'une des revendications 16 à 23, dans lequel l'indice de qualité de signal détecté par le détecteur d'indice de qualité de signal est une amplitude d'un signal de vobulation, et une position focale et une aberration sphérique qui maximisent l'amplitude du signal de vobulation sont recherchées dans la recherche bidimensionnelle.

29. Procédé de traitement d'information optique selon l'une des revendications 16 à 28, dans lequel une information expérimentale est enregistrée sur le support d'enregistrement d'information optique, et le signal de tête converti à partir de la lumière réfléchie par le support d'enregistrement d'information optique est obtenu en reproduisant l'information expérimentale.

30. Procédé de traitement d'information optique selon la revendication 29, dans lequel l'indice de qualité de signal comprend un signal d'erreur de focalisation et un signal d'erreur de poursuite ;

la recherche bidimensionnelle comprend une recherche de position focale comprenant de faire varier la position focale de manière à rechercher une position focale qui maximise l'amplitude du signal d'erreur de poursuite, et une recherche d'aberration sphérique comprenant de faire varier l'aberration sphérique de manière à rechercher une aberration sphérique qui maximise l'amplitude du signal d'erreur de focalisation ; et comprend en outre un enregistrement par tête optique pour enregistrer l'information expérimentale sur le support d'enregistrement d'information optique en préalable à la sortie du signal de tête optique, à une aberration sphérique qui maximise l'amplitude du signal d'erreur de focalisation et à une position focale qui maximise l'amplitude du signal d'erreur de poursuite.

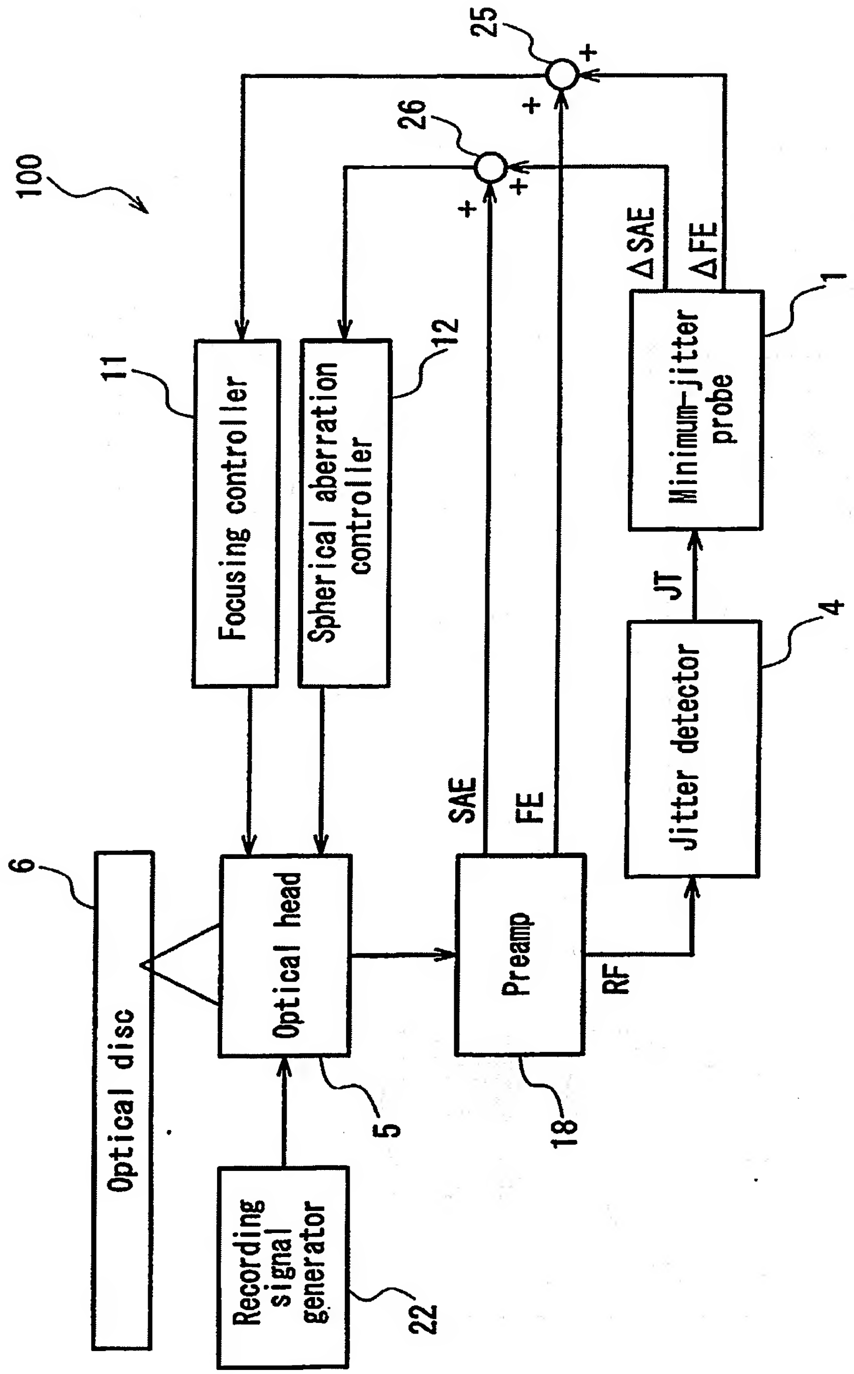

100
Optical disc
6
Optical head
5
Recording signal generator
22
Focusing controller
11
Spherical aberration controller
12
Preamp
18
SAE
FE
RF
Jitter detector
4
JT
Minimum-jitter probe
1
ΔSAE
ΔFE
26
25
+
+
+
+

FIG. 1

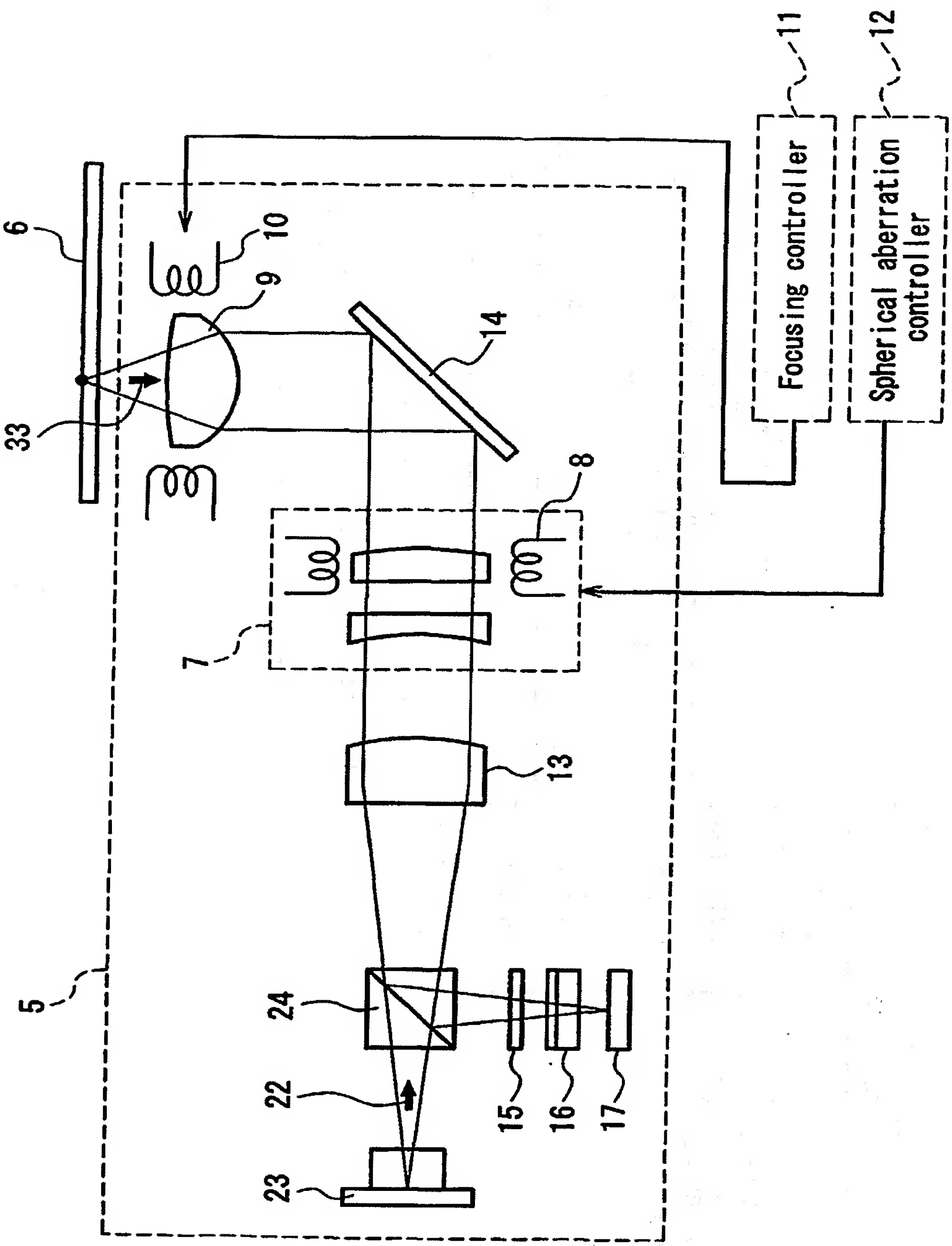
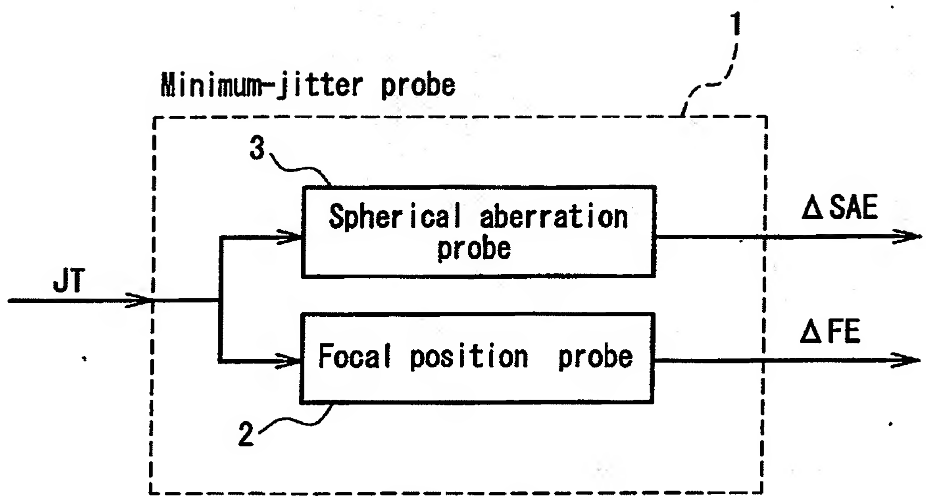

Focusing controller
Spherical aberration controller
5
6
7
8
9
10
11
12
13
14
15
16
17
22
23
24
33

FIG. 2



1
Minimum-jitter probe
3
Spherical aberration probe
JT
Focal position probe
2
Δ SAE
Δ FE

FIG. 3

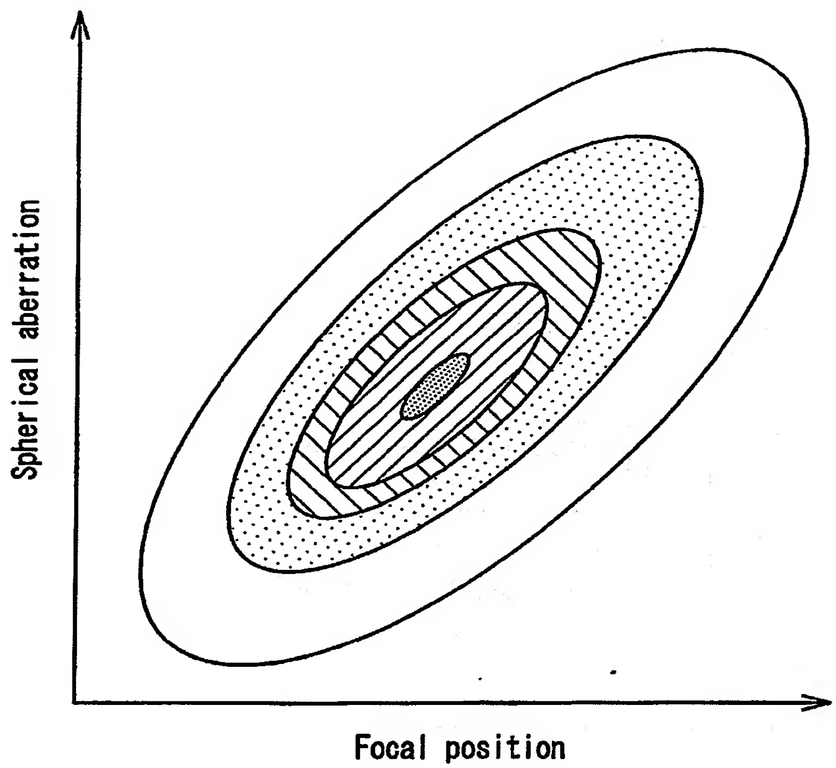


FIG. 4

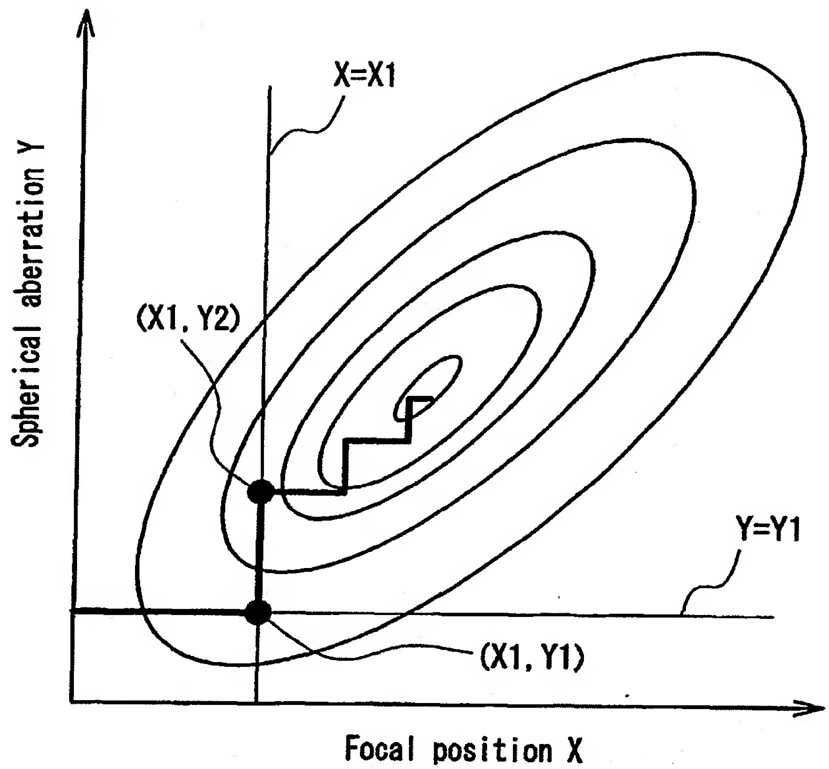


FIG. 5

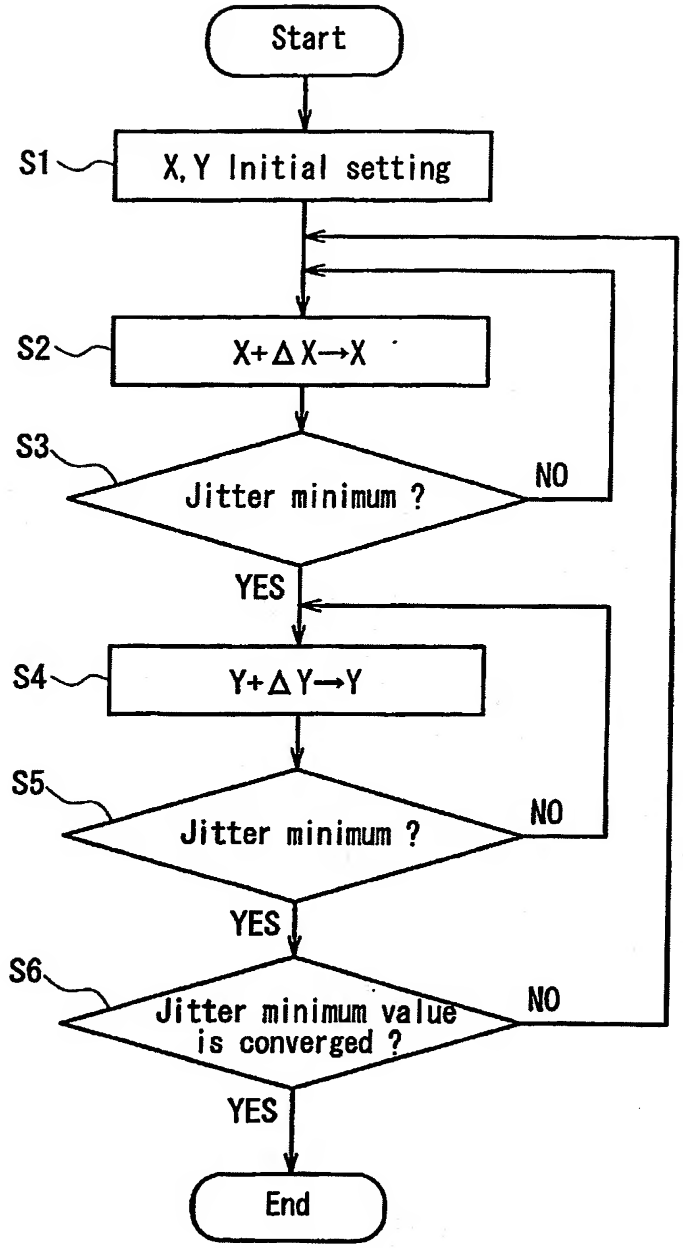

Start
S1
X, Y Initial setting
S2
X+ΔX→X
S3
Jitter minimum ?
NO
YES
S4
Y+ΔY→Y
S5
Jitter minimum ?
NO
YES
S6
Jitter minimum value is converged ?
NO
YES
End

FIG. 6

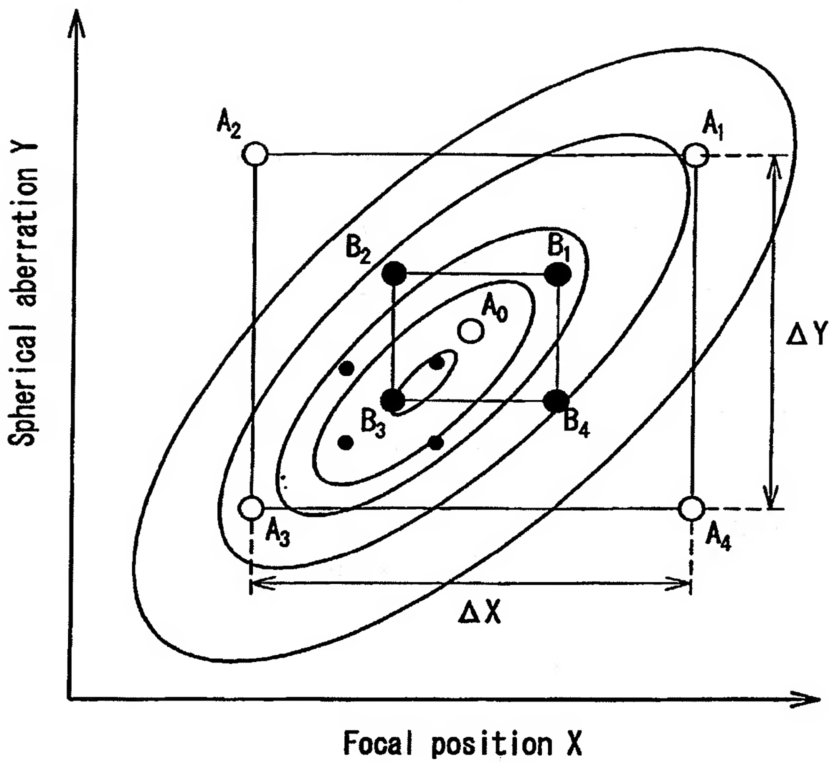

Spherical aberration Y
A2
A1
B2
B1
A0
ΔY
B3
B4
A3
A4
ΔX
Focal position X

FIG. 7

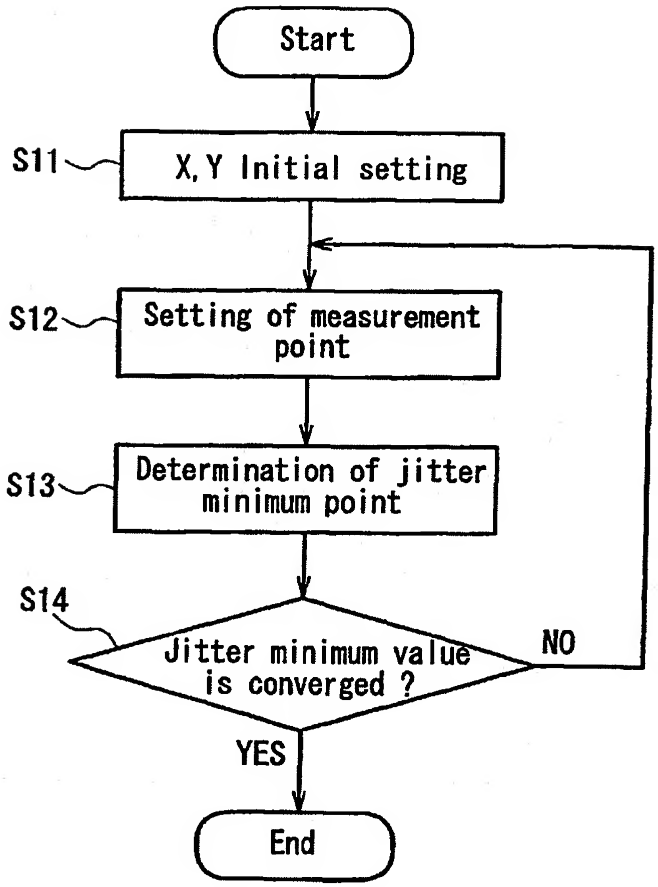

Start
S11
X, Y Initial setting
S12
Setting of measurement point
S13
Determination of jitter minimum point
S14
Jitter minimum value is converged ?
NO
YES
End

FIG. 8

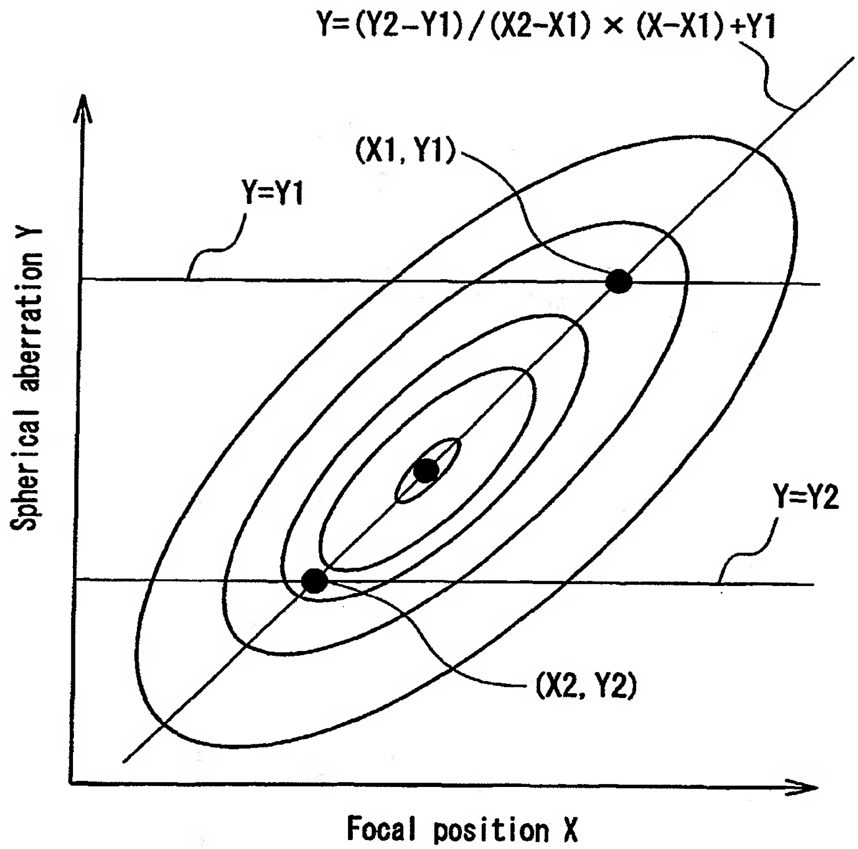

Y=(Y2-Y1)/(X2-X1) × (X-X1)+Y1
(X1, Y1)
Y=Y1
Spherical aberration Y
Y=Y2
(X2, Y2)
Focal position X

FIG. 9

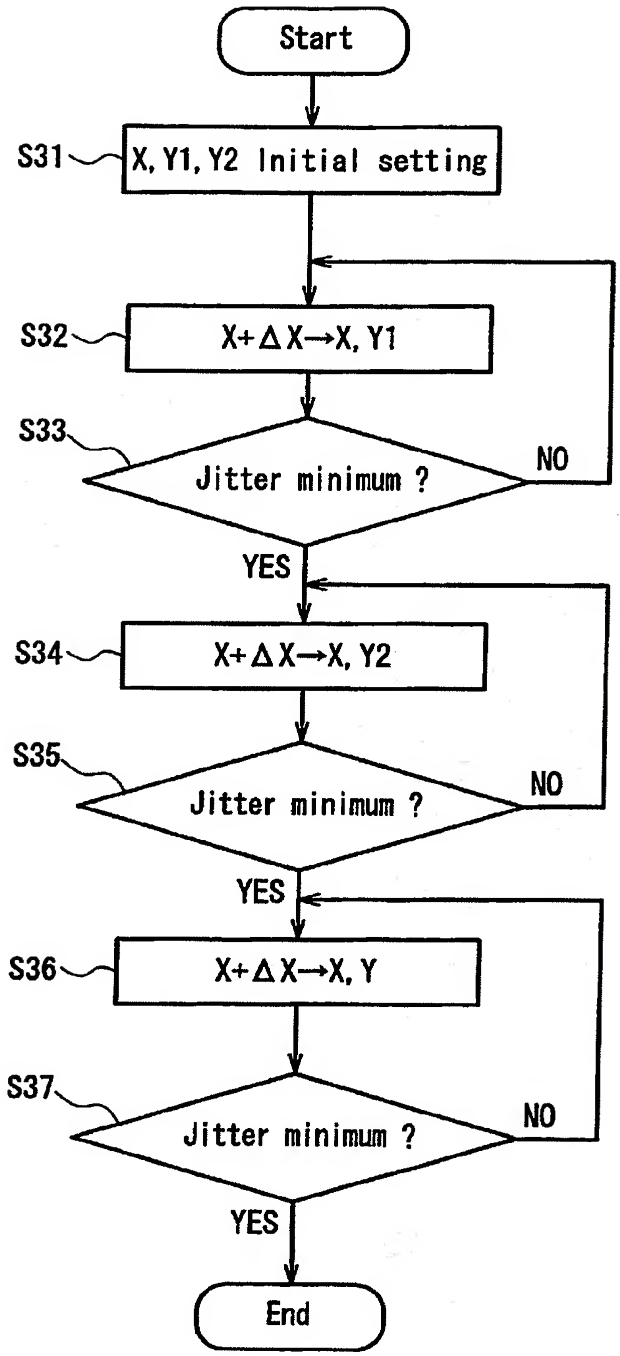

Start
S31
X, Y1, Y2 Initial setting
S32
X+ΔX→X, Y1
S33
Jitter minimum ?
NO
YES
S34
X+ΔX→X, Y2
S35
Jitter minimum ?
NO
YES
S36
X+ΔX→X, Y
S37
Jitter minimum ?
NO
YES
End

FIG. 10

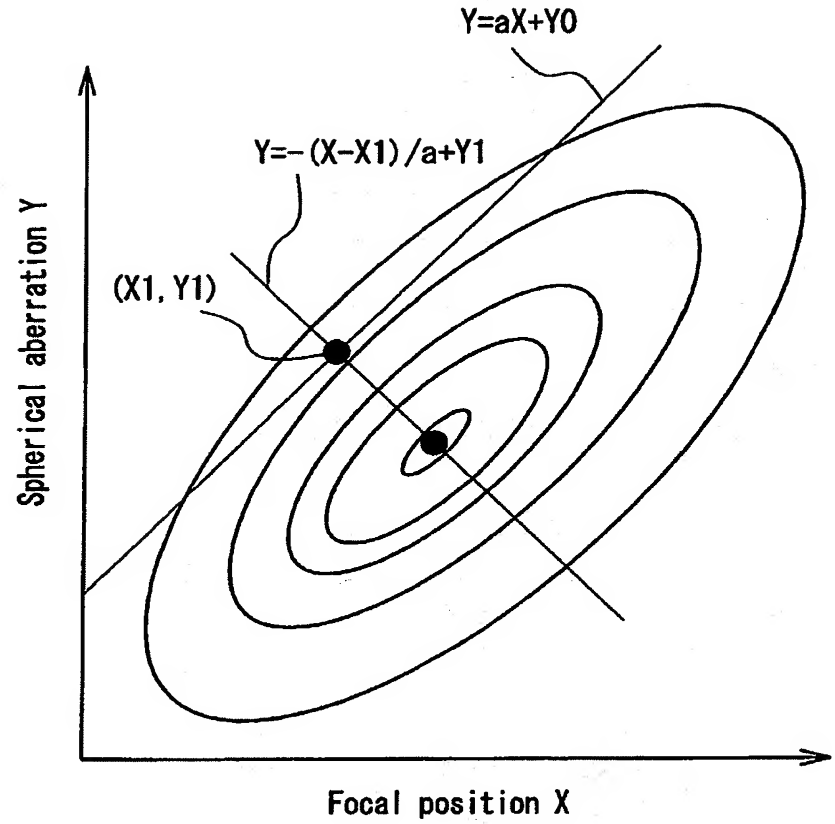

Y=aX+Y0
Y=-(X-X1)/a+Y1
(X1, Y1)
Spherical aberration Y
Focal position X

FIG. 11

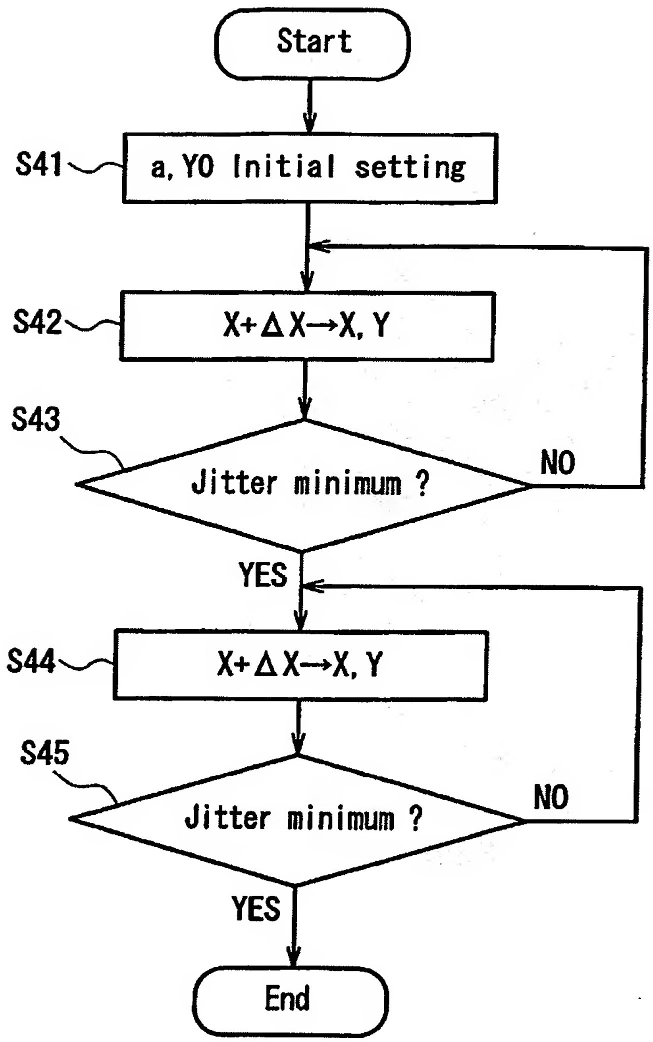
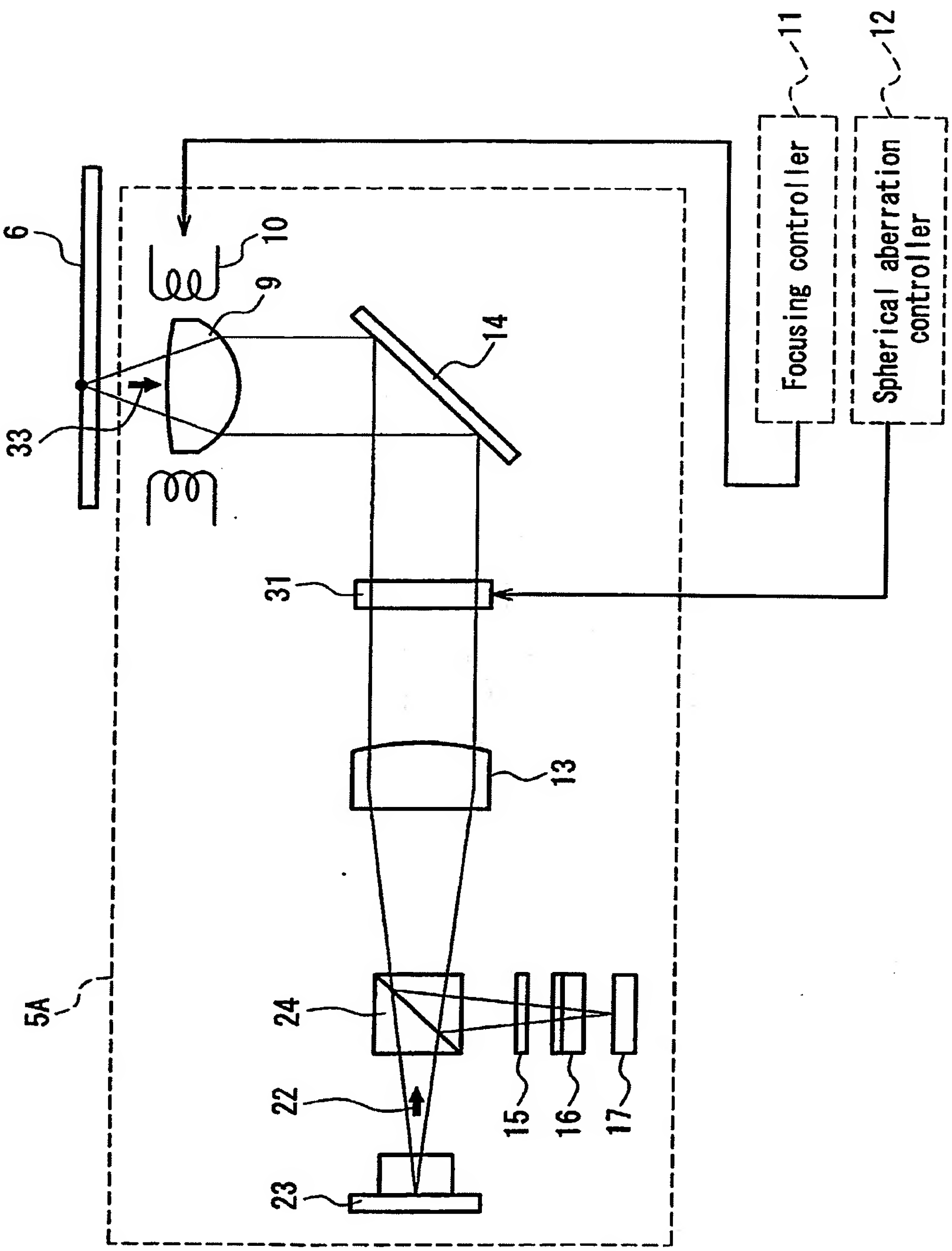

Start
S41
a, Y0 Initial setting
S42
X+ΔX→X, Y
S43
Jitter minimum ?
NO
YES
S44
X+ΔX→X, Y
S45
Jitter minimum ?
NO
YES
End

FIG. 12



Focusing controller
Spherical aberration controller
11
12
6
10
9
33
14
31
13
5A
24
22
23
15
16
17

FIG. 13

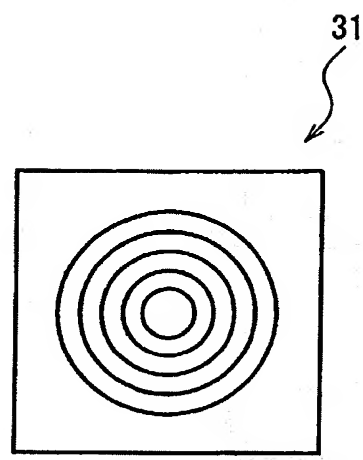


FIG. 14

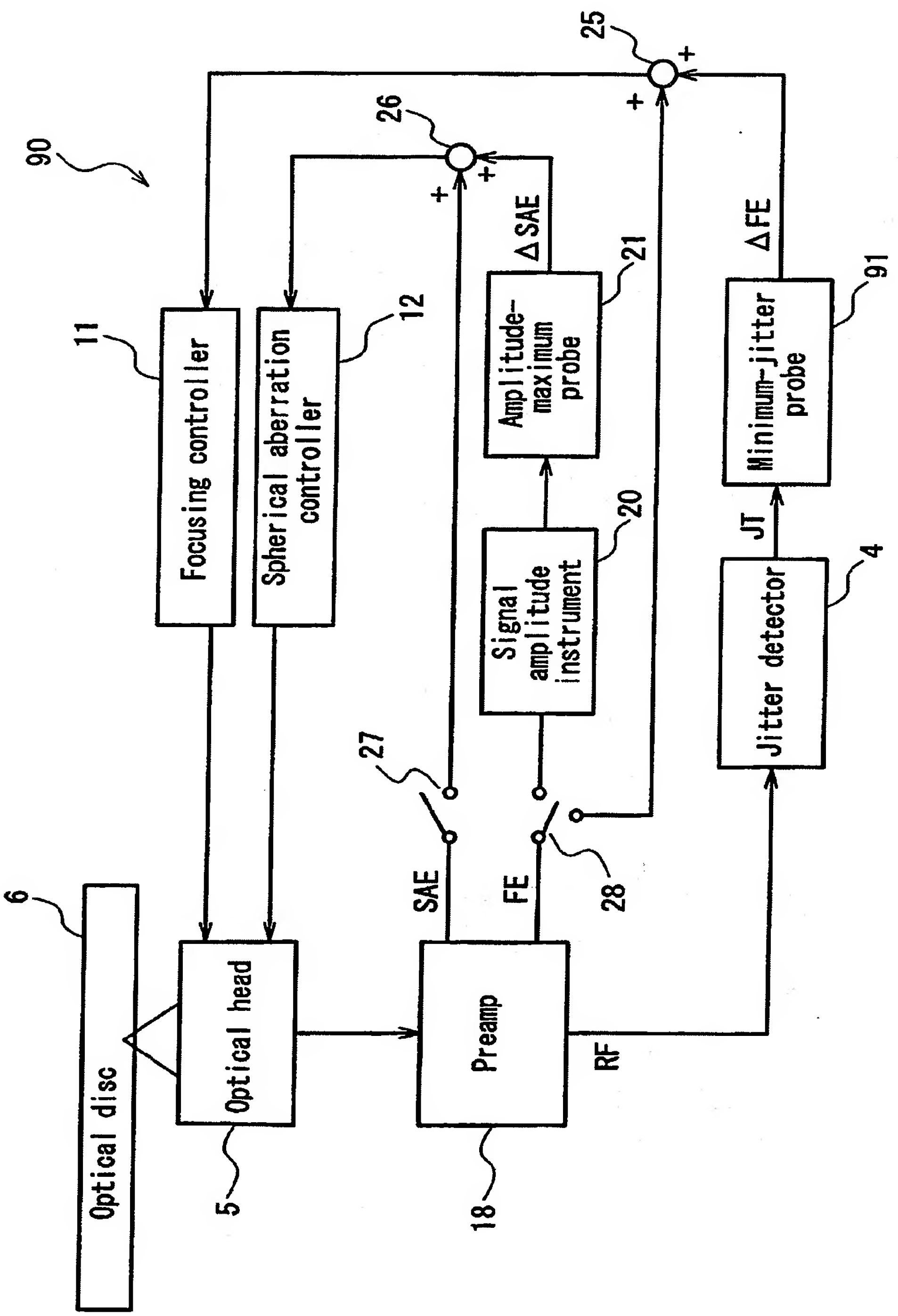


FIG. 15
PRIOR ART

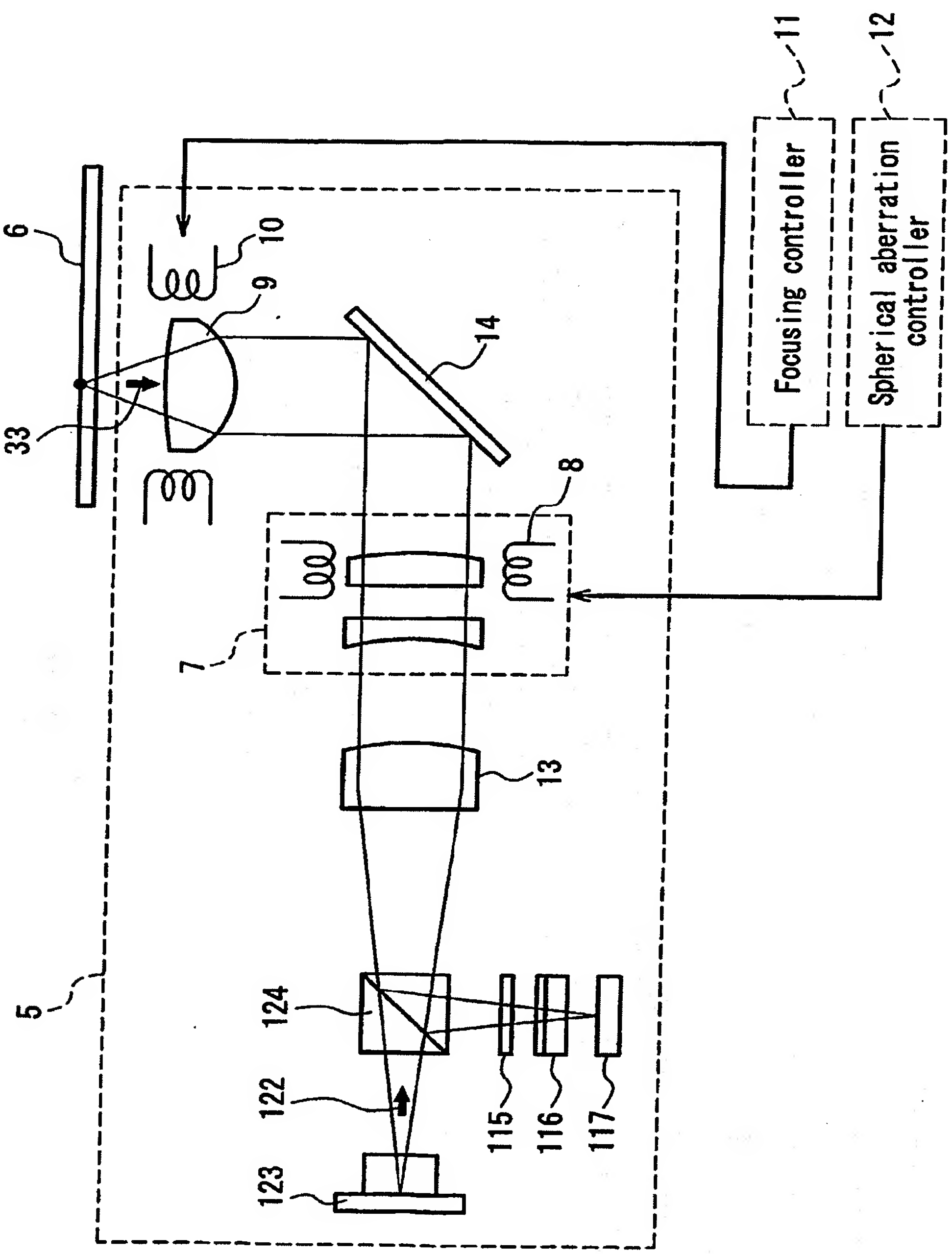


FIG. 16
PRIOR ART

FIG. 17A
PRIOR ART

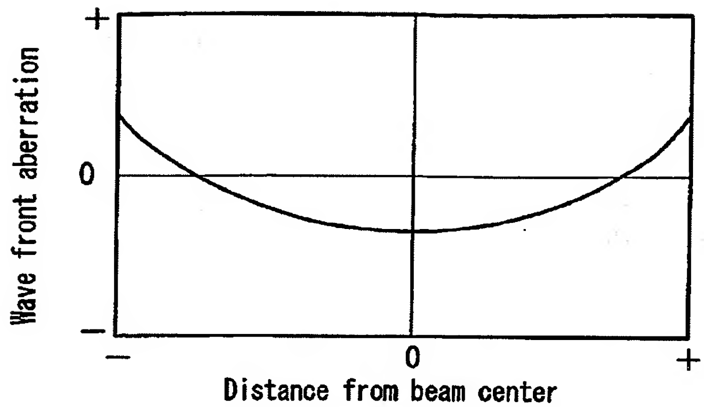


FIG. 17B
PRIOR ART

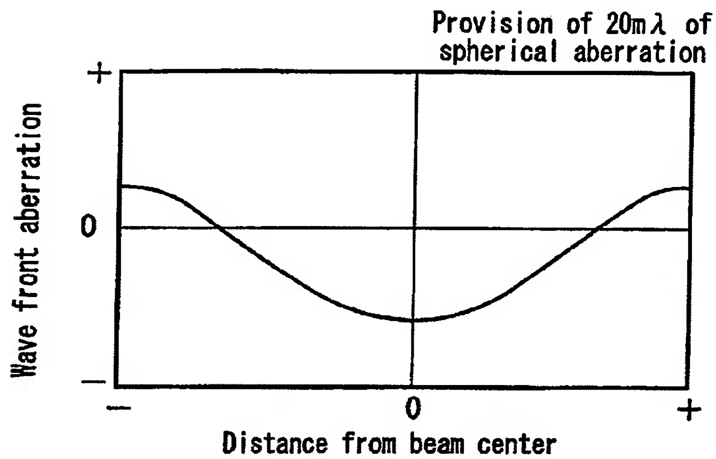
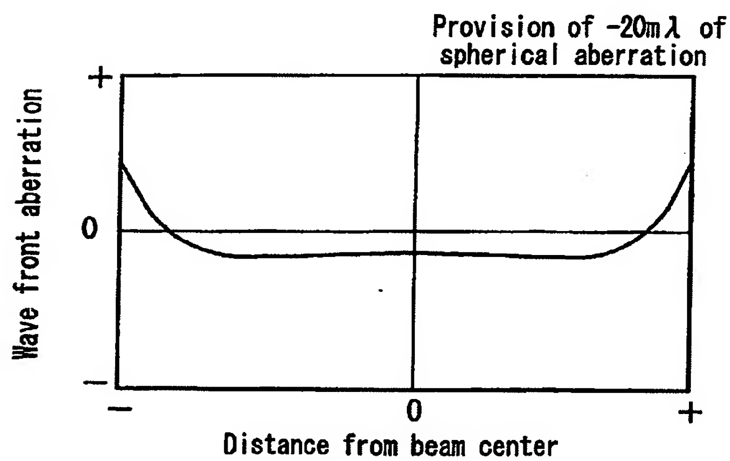


FIG. 17C
PRIOR ART



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Patent documents cited in the description

- US 5848036 B1 **[0003]**
- JP 10106012 A **[0004]**
- JP 2000057616 A **[0005]**
- US 6229600 B1 **[0006]**